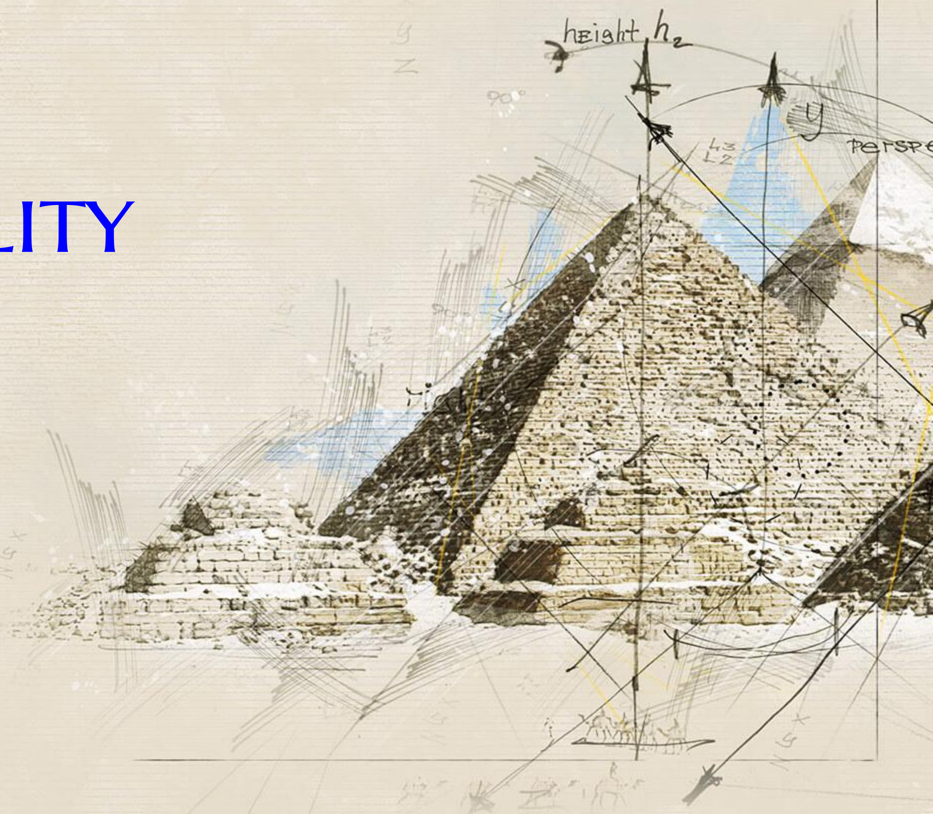
BIM & Sustainability



Omar selim
Omar.selm@gmail.com

Hello!

I am Omar Selim

Founder of BIMarabia

I am here because I love to give presentations.

You can find me at @BIMarabia



BIM



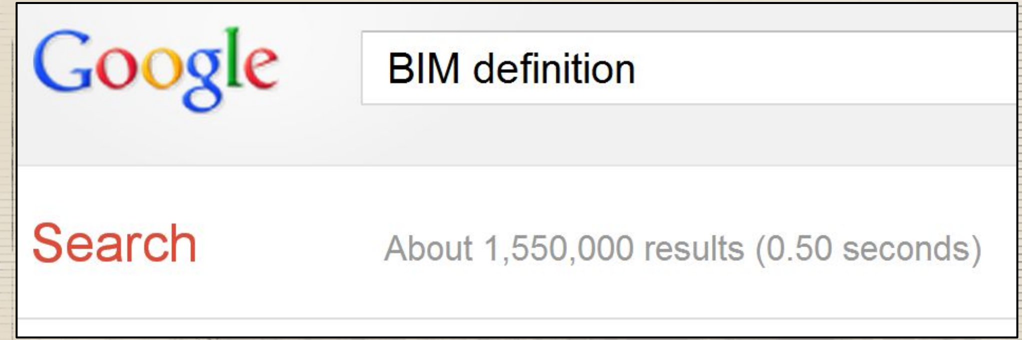


Sir Christopher Wren’s Great Model. 1672

What is BIM?

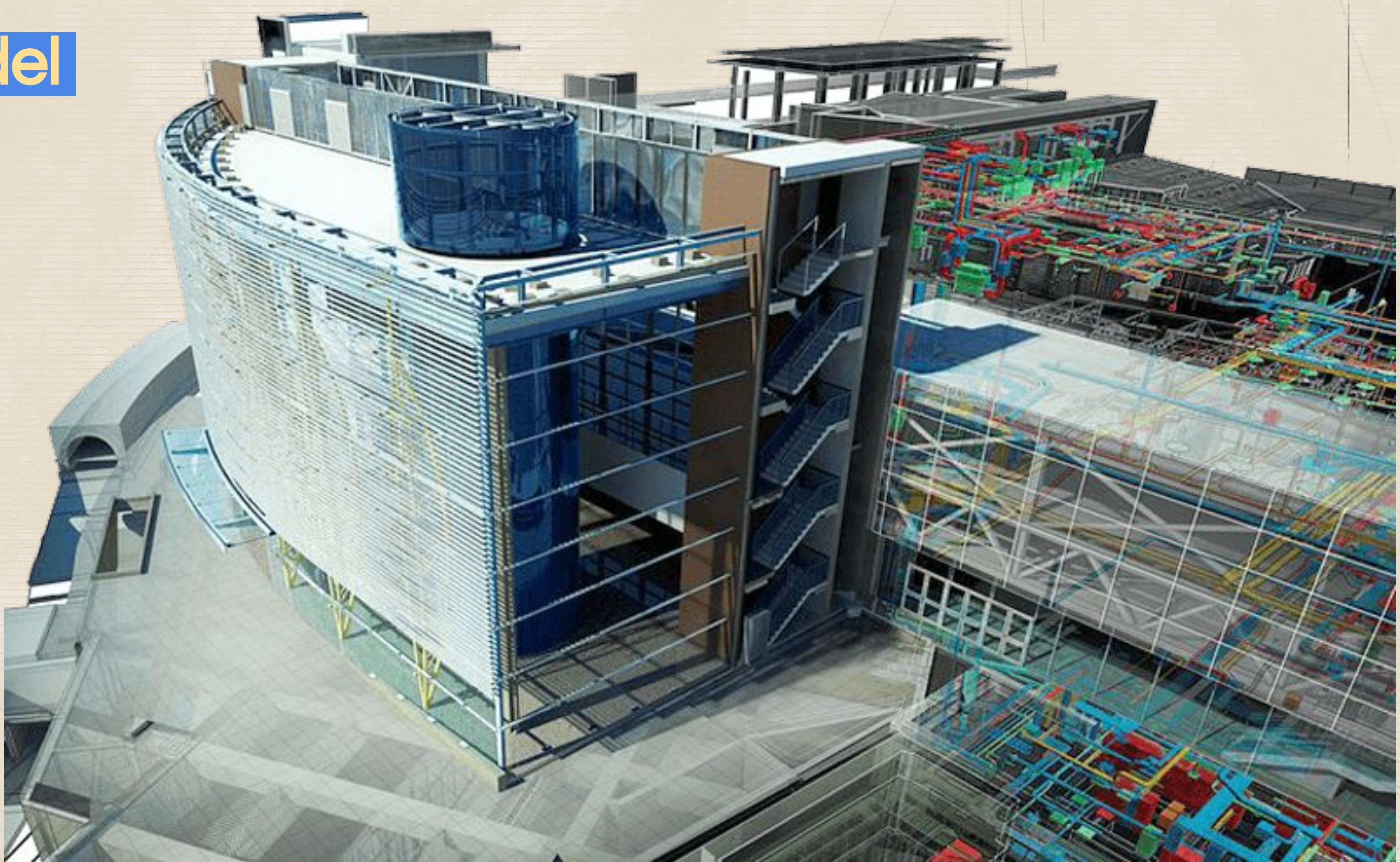
Building Information Modeling
Building Information Management

Better Information For Management.

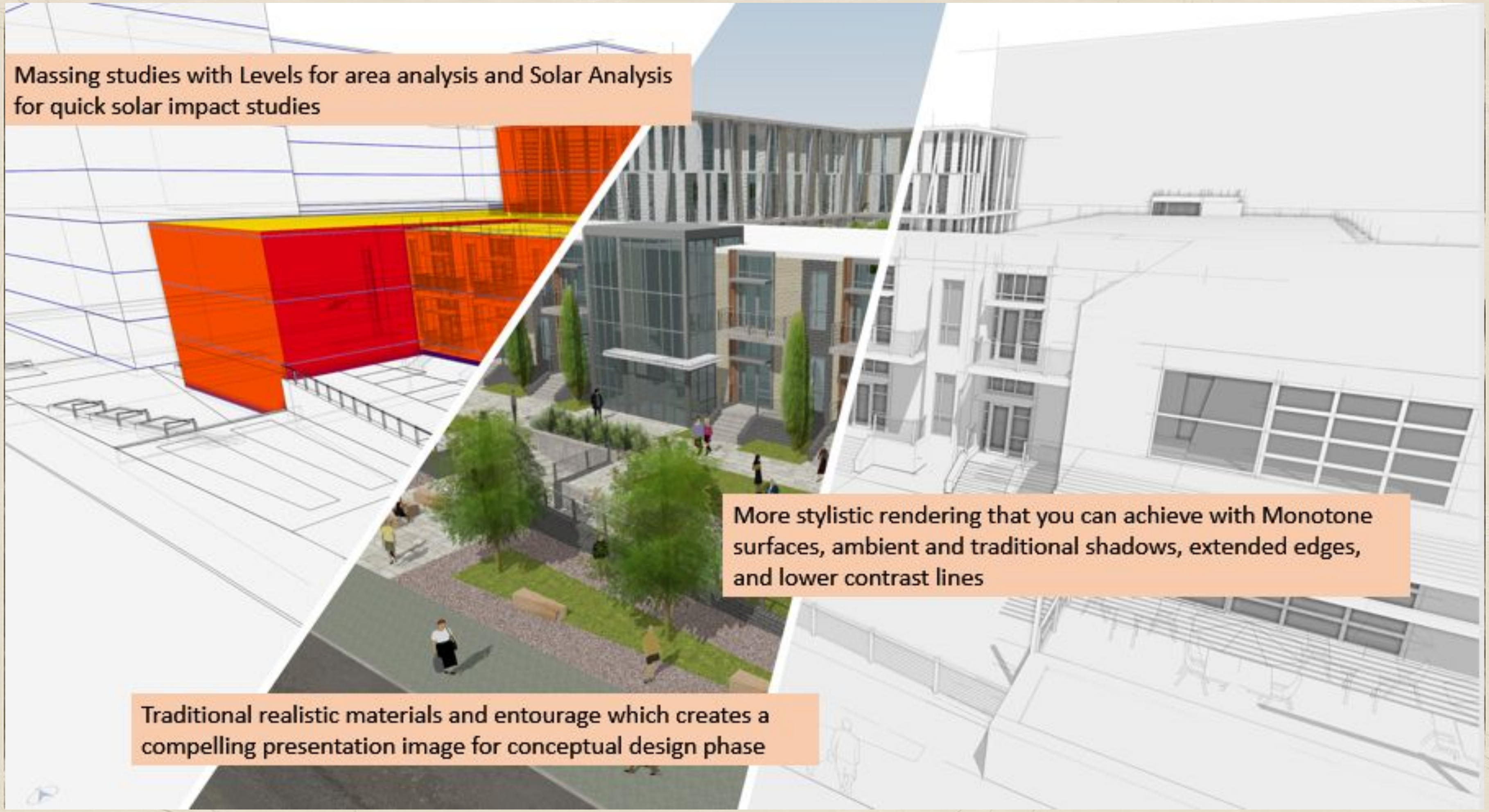


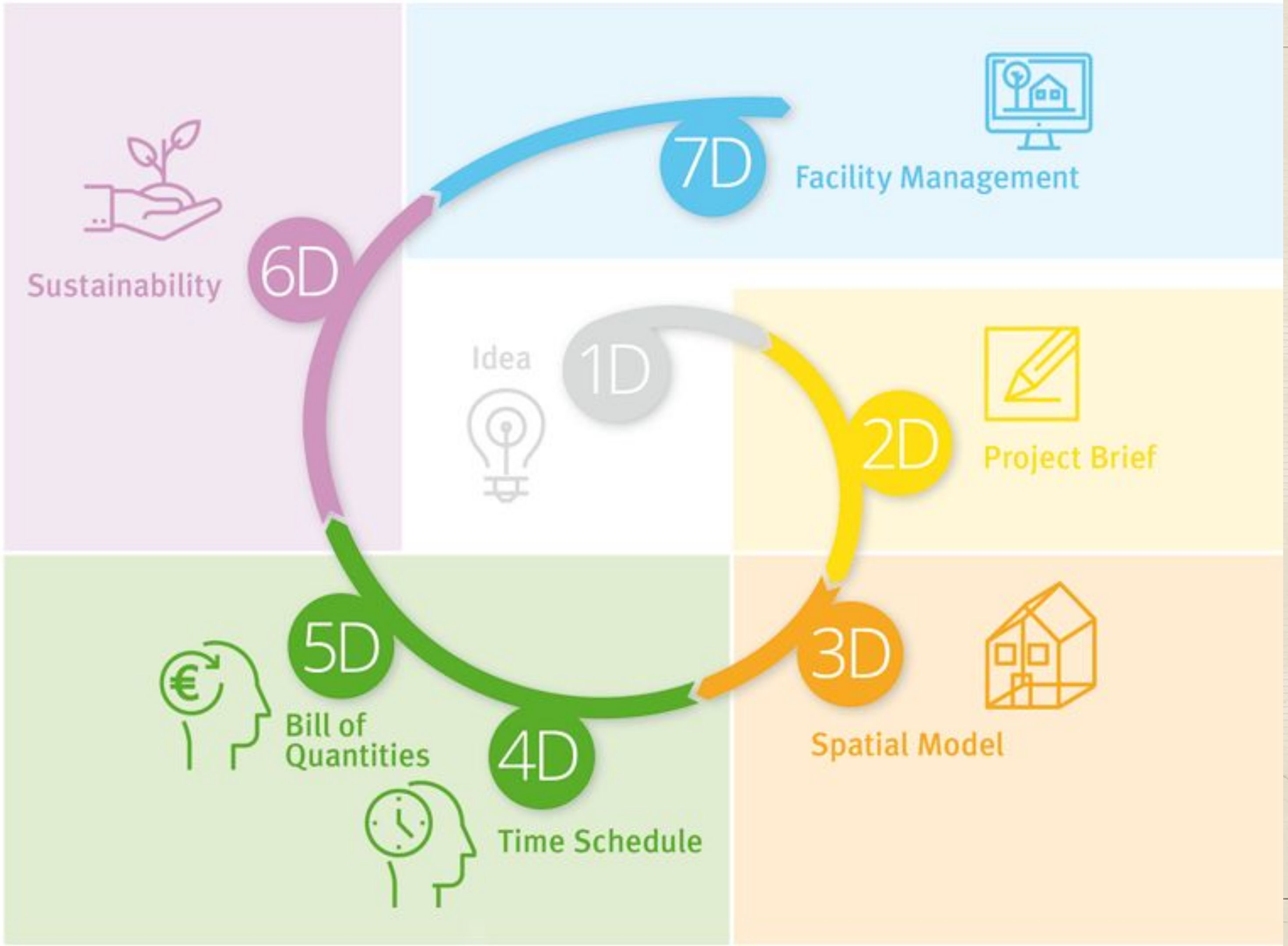
“a digital representation of physical and functional characteristics of a facility. As such it serves as a shared knowledge resource for information about a facility forming a reliable basis for decisions during its lifecycle from inception onward.”

BIM Model

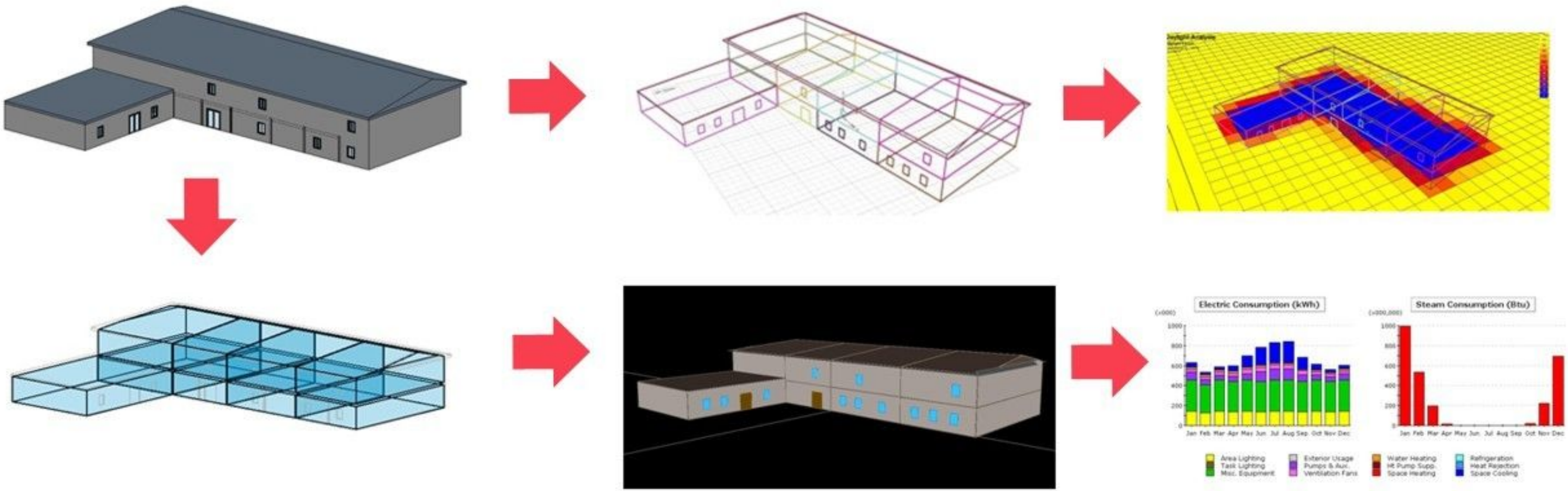





Massing studies with Levels for area analysis and Solar Analysis for quick solar impact studies
More stylistic rendering that you can achieve with Monotone surfaces, ambient and traditional shadows, extended edges, and lower contrast lines
Traditional realistic materials and entourage which creates a compelling presentation image for conceptual design phase

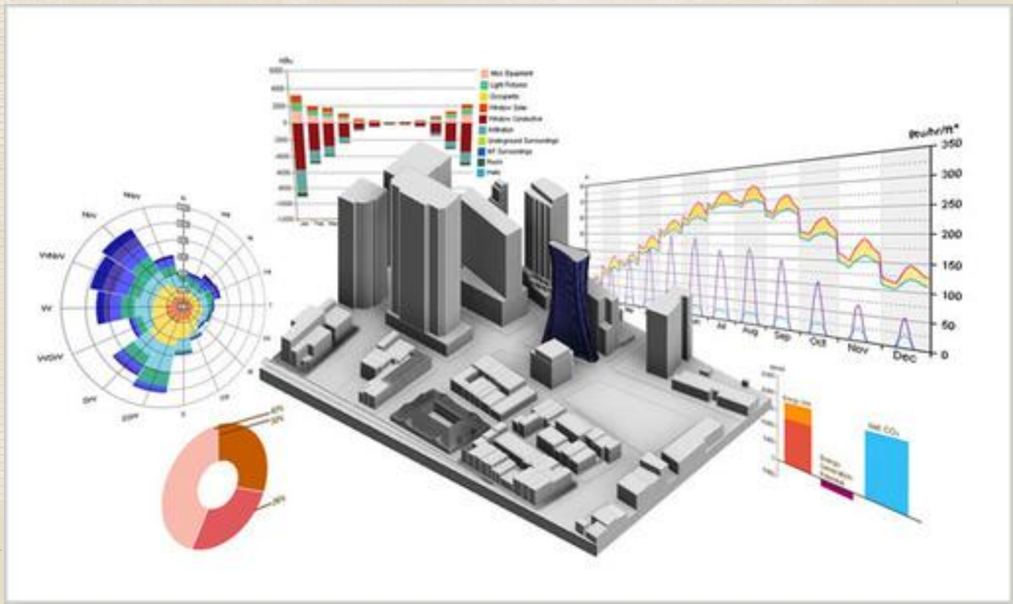

7D
Facility Management
6D
Sustainability
Idea
1D
2D
Project Brief
3D
Spatial Model
4D
Time Schedule
5D
Bill of Quantities

Sustainability



Sustainable

- - Development "meeting the needs of the present generation without compromising the ability of future generations to meet their needs." – Brundtland Report



Sustainable Construction and Buildings

- Buildings use 46% of all energy – up to 70% in major cities
- Construction uses 53% of primary materials
- Construction has second biggest environmental footprint after food
- 13 million tonnes of materials delivered and not used
- 90 million tonnes of waste – 3 times domestic output
- 21% of all hazardous waste in UK is construction waste92% of clients said that designers' drawings are typically not sufficient for construction

37% of materials used in construction become waste

10% of the cost of a project is typically due to change orders

38% of carbon emissions are from buildings not cars

Why accept this ?........

CMAA Owners survey 2005, CMAA Industry Report 2007, Economist Magazine 2002
Buildings contribute 40% of global carbon emissions.

The UK government's Construction 2025 strategy targets a 33% reduction in the whole-life cost of built assets and a 50% reduction in greenhouse gas emissions by 2025.

This is a stepping stone on the way to the target of cutting emissions by 80% by 2050 (compared with 1990 levels).

Sustainable Design



Energy

Lighting and equipment

Heating, cooling, and ventilation

Occupant processes

- Minimize operating energy
- Utilize renewable energy
- Select and design site



Water

Potable supply for occupants

Non-potable supply for processes

Storm water runoff

- Reduce water use
- Reclaim gray water
- Manage Hydraulics and Hydrology (H&H)



Materials

Site work

Structure, envelope, and finishes

Furnishings and equipment

- Implement low impact development
- Seek renewable sources
- Minimize embodied measures

Green buildings

- Buildings or homes that are more energy efficient, produce less waste and are healthier to be inside
- Buildings around the globe consume about 48% of the total electricity produced.
- Need of Green Buildings to decrease the demand.
- Typical Problems in Construction Industry Energy Consumption by Buildings 88



Building Cost

Design	Build	Operate	Dispose	Total
3%	17%	Run/Maintain 40%	?%	100% Cost of Ownership
		Repair 30%		
		Periodic Replacement/ Refurbishment 10%		
1Year	2 Years	25 Years	1 Year	Total

Ref. Tumer and Townsend, Construction and Management Consultants

Why BIM ,,Benefits of BIM,,

The color of BIM is green.

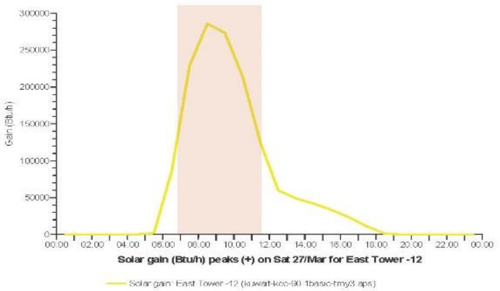
Sustainability can be defined as the ability to meet the needs of the present without compromising the ability of future generations to meet their own needs.

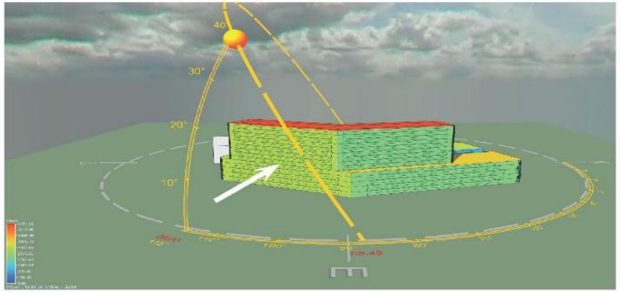
“Sustainability begins with really understanding **how you will use a building.**

BIM lets you model the space and run analytics so you can make sure the building will efficiently support the people who use it.”



Why BIM ,,Benefits of BIM,,



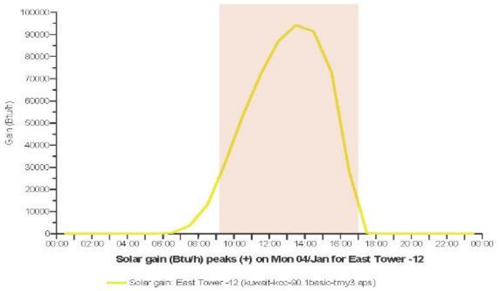


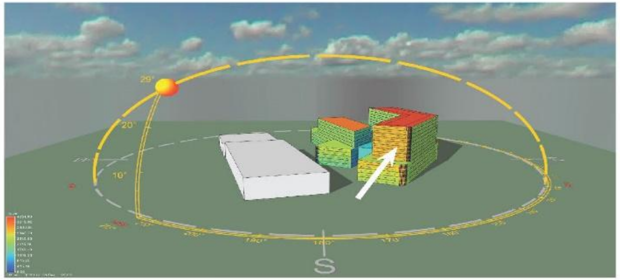
Analysis of total annual hours of sun exposure per major facade orientation. Provide shading to control the peak time of solar gain. Shading will reduce energy use and improve occupant comfort.

Red = Most , Blue = Least

EAST ELEVATION
Sun location: Horizontal 115 d / Vertical 40 d

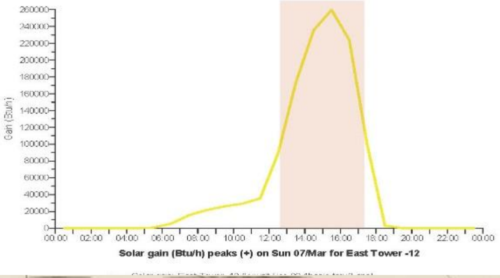
Shading approach: Both horizontal and vertical shading due to high sun angle.

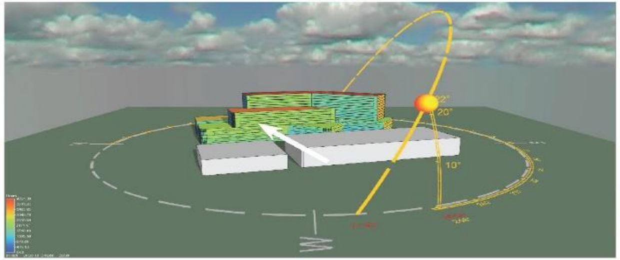




SOUTH ELEVATION
Sun location: Horizontal 213 d / Vertical 29 d

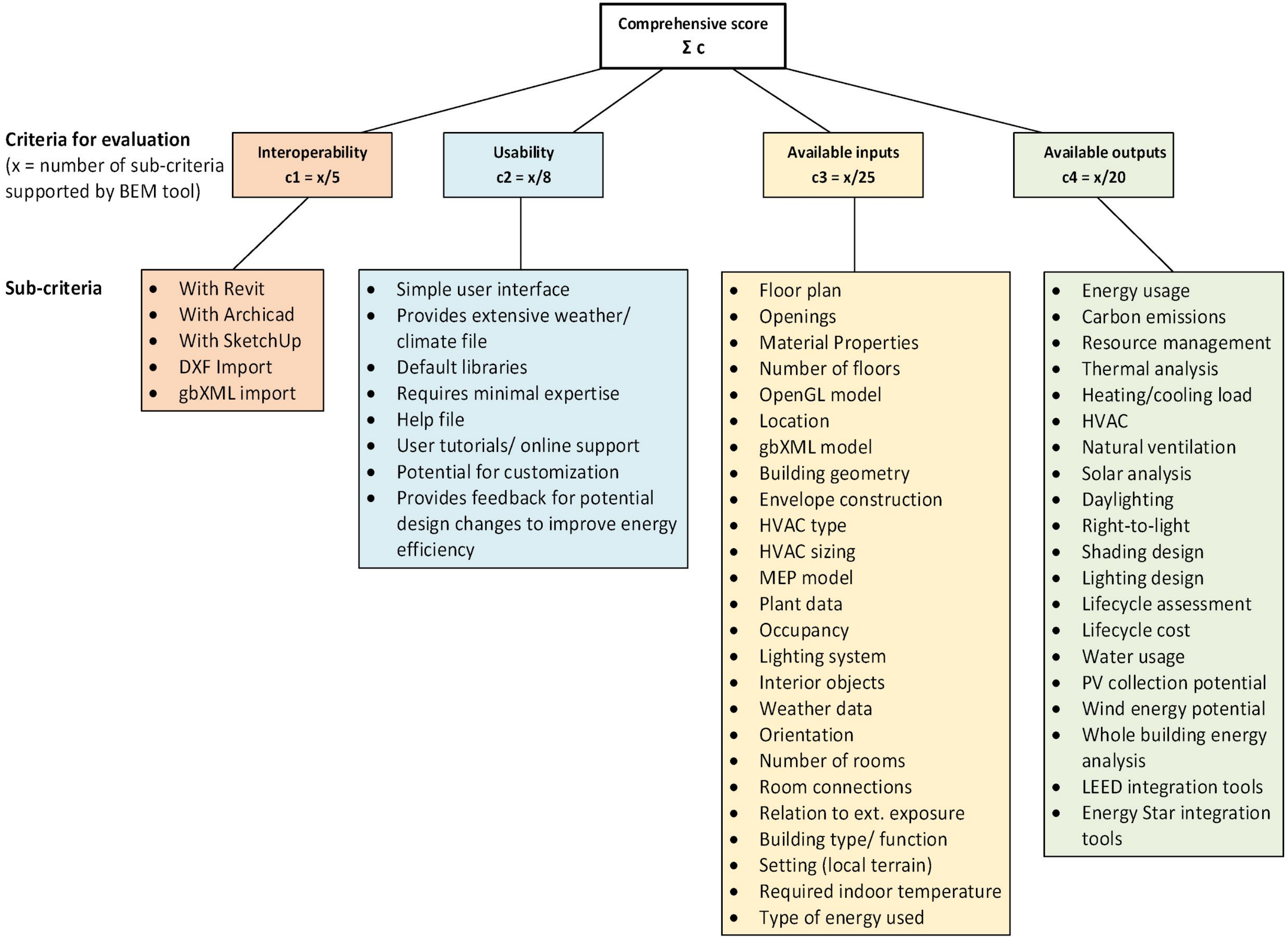
Shading approach: Horizontal shading with deep set windows.

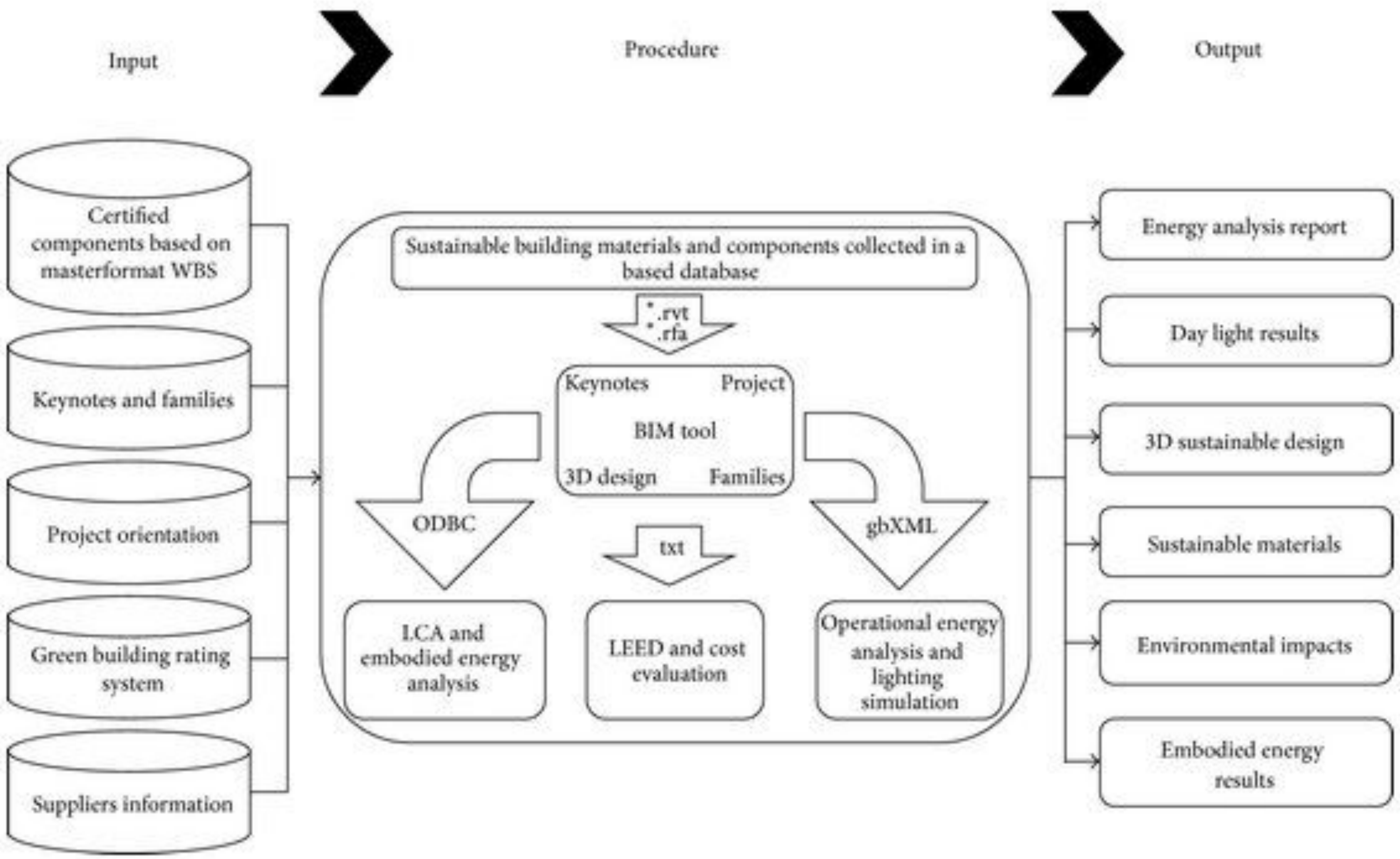




WEST ELEVATION
Sun location: Horizontal 248 d / Vertical 22 d

Shading approach: Screen to control low sun angle.


Comprehensive score
Σ c
Criteria for evaluation
(x = number of sub-criteria supported by BEM tool)
Interoperability
c1 = x/5
Usability
c2 = x/8
Available inputs
c3 = x/25
Available outputs
c4 = x/20
Sub-criteria
With Revit
With Archicad
With SketchUp
DXF Import
gbXML import
Simple user interface
Provides extensive weather/ climate file
Default libraries
Requires minimal expertise
Help file
User tutorials/ online support
Potential for customization
Provides feedback for potential design changes to improve energy efficiency
Floor plan
Openings
Material Properties
Number of floors
OpenGL model
Location
gbXML model
Building geometry
Envelope construction
HVAC type
HVAC sizing
MEP model
Plant data
Occupancy
Lighting system
Interior objects
Weather data
Orientation
Number of rooms
Room connections
Relation to ext. exposure
Building type/ function
Setting (local terrain)
Required indoor temperature
Type of energy used
Energy usage
Carbon emissions
Resource management
Thermal analysis
Heating/cooling load
HVAC
Natural ventilation
Solar analysis
Daylighting
Right-to-light
Shading design
Lighting design
Lifecycle assessment
Lifecycle cost
Water usage
PV collection potential
Wind energy potential
Whole building energy analysis
LEED integration tools
Energy Star integration tools


Input
Procedure
Output
Certified components based on masterformat WBS
Keynotes and families
Project orientation
Green building rating system
Suppliers information
Sustainable building materials and components collected in a based database
*.rvt
*.rfa
Keynotes
Project
BIM tool
3D design
Families
ODBC
txt
gbXML
LCA and embodied energy analysis
LEED and cost evaluation
Operational energy analysis and lighting simulation
Energy analysis report
Day light results
3D sustainable design
Sustainable materials
Environmental impacts
Embodied energy results

Sustainable Design Simulations Run on Information Models and Databases

XML and IFCs have emerged as sustainable design information modeling standards.

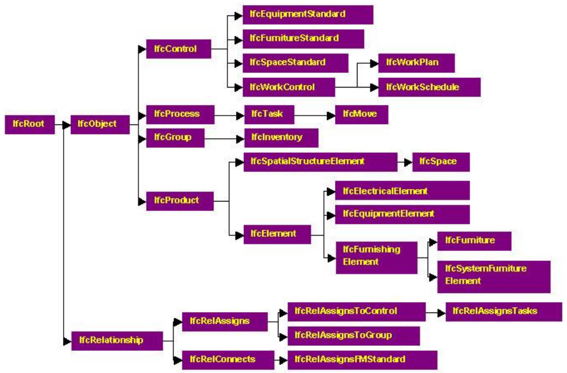
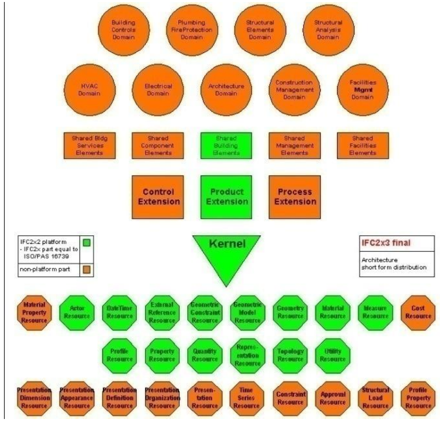


Figure 10: Tracing inheritance structure to IfcRoot



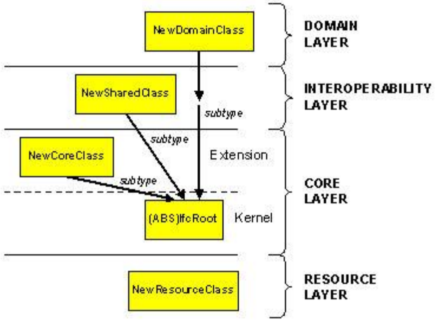
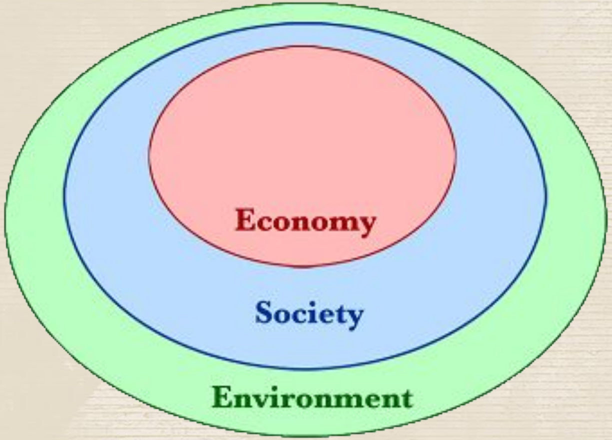
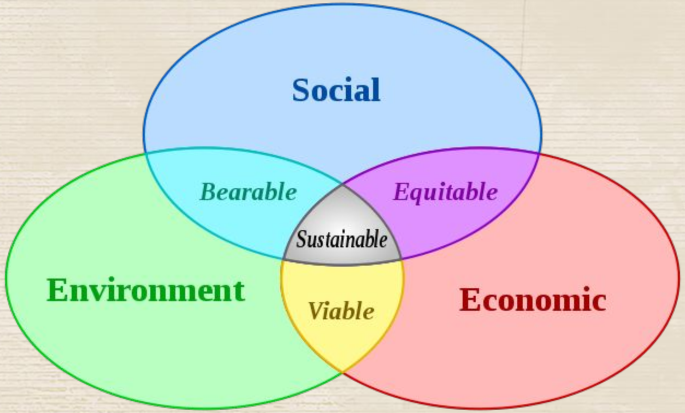


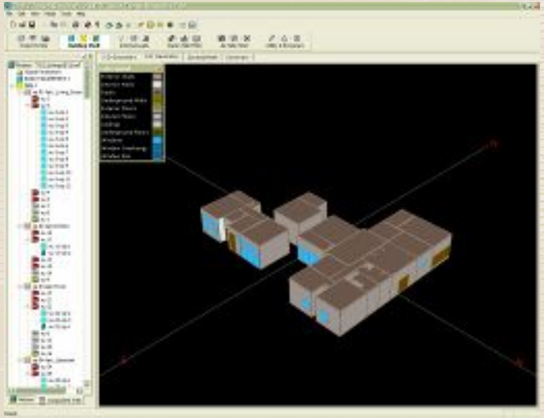
Figure 13: IfcRoot as the common supertype

Sustainability: Graphical Models

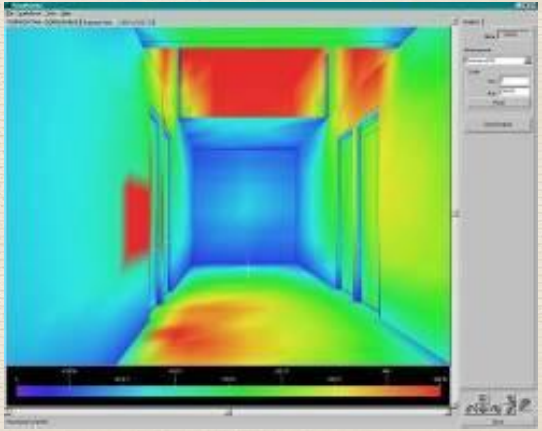




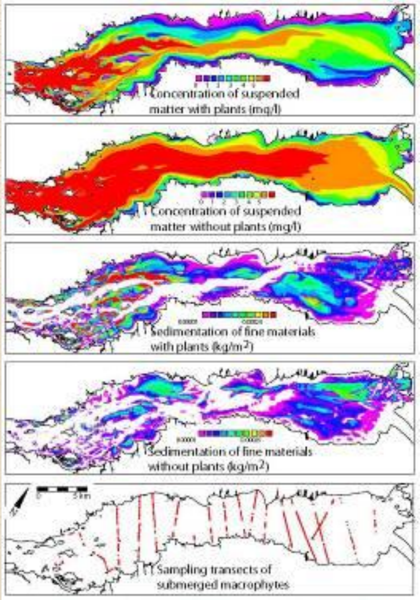
Information Models Enable Sustainable Design Simulations



Educational Campus Building
Energy Use Simulation



Educational Campus Building
Daylighting Simulation



Lake Ecology Simulation

What are the main sustainability challenges that society faces today?

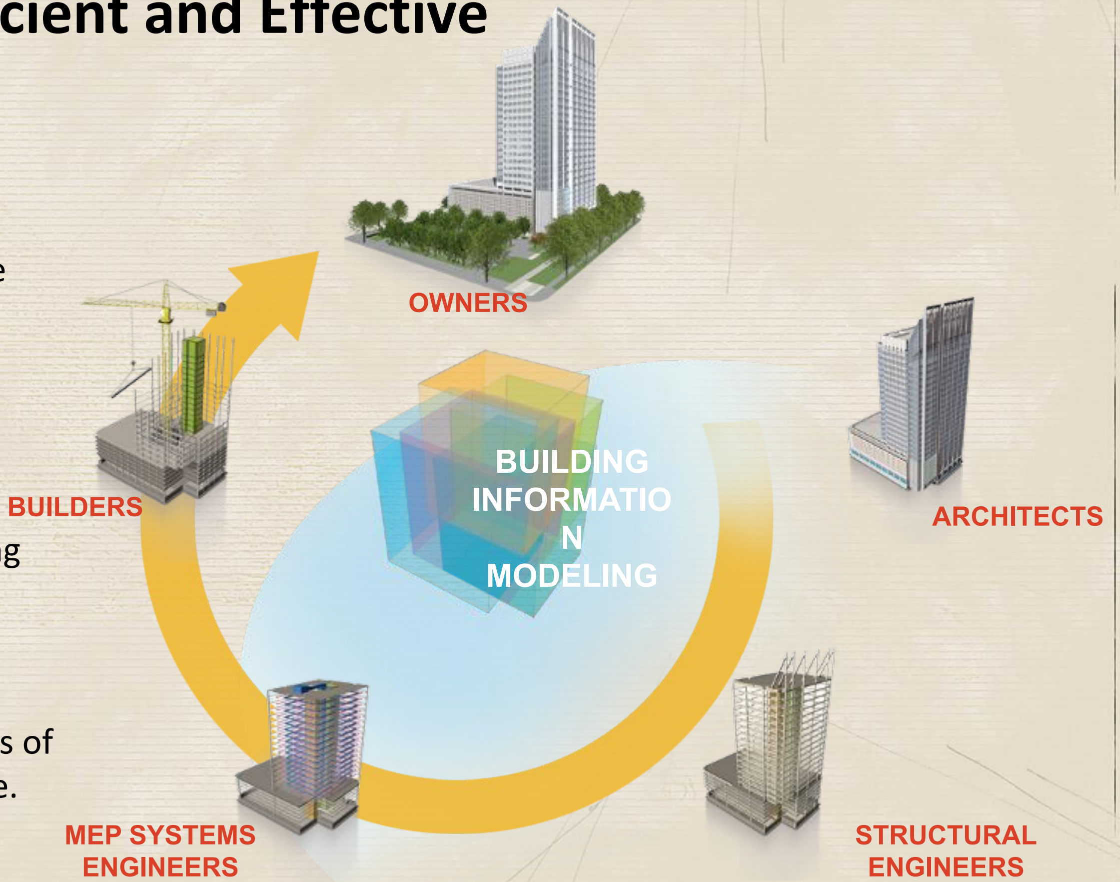
- Mitigating Global Warming and Associated Climate Change While Meeting the Increasing Needs for Energy

Reversing the Loss of Biodiversity

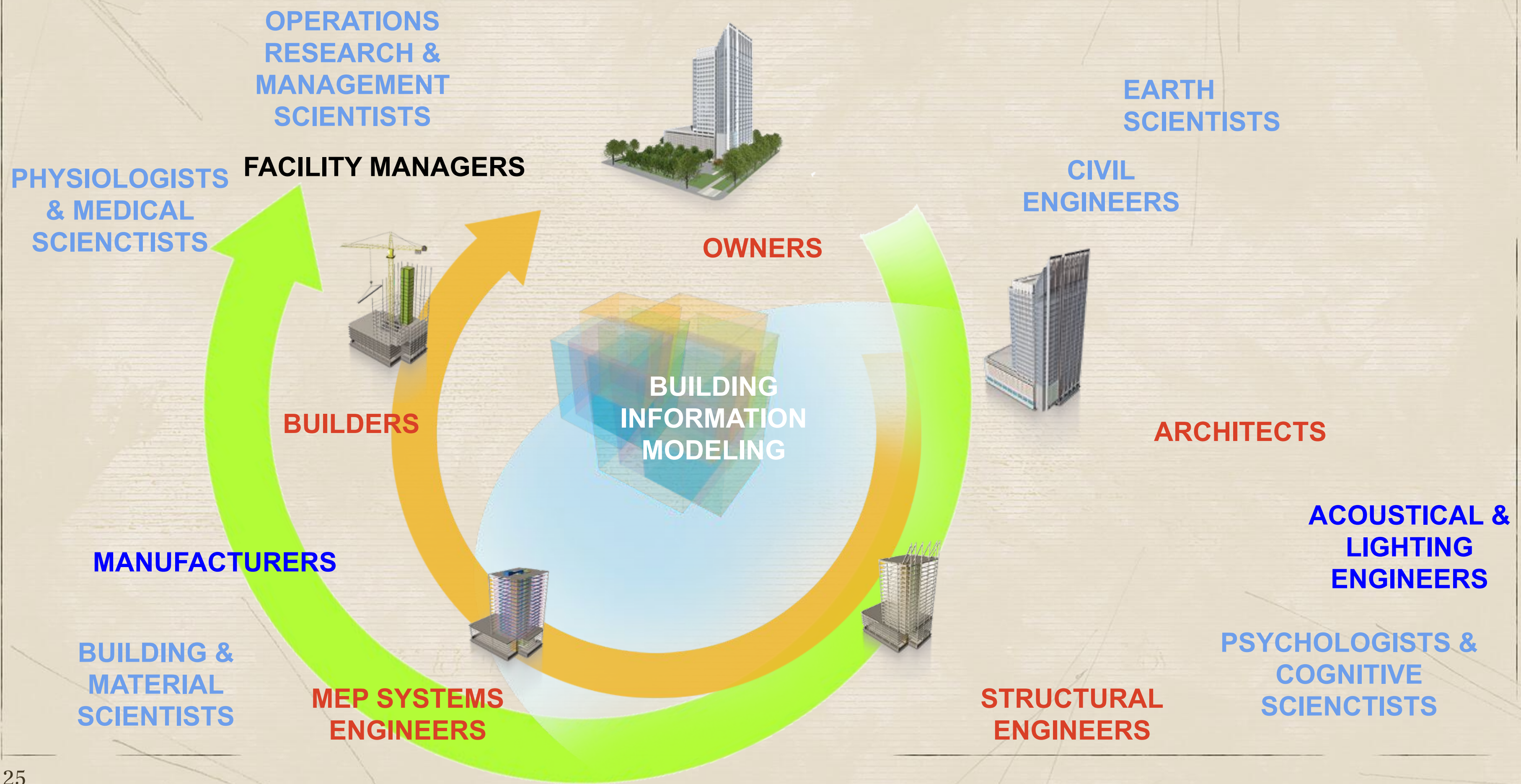
- Maintaining and Improving Access to Fresh Water
- Maintaining and Improving Access to Healthy and Affordable Food through Sustainable Agriculture
- Maintaining and Expanding Critical Infrastructure that Mitigates Environmental Impacts on Human Health and Improves the Quality of Human Life

BIM is a Catalyst for Efficient and Effective Sustainable Design

- The most advanced design technology available.
- Makes information available for analysis earlier in design process.
- Supports an improved collaborative process.
- Reduces the effort of increasingly complex building design.
- Facilitates a holistic design approach.
- Enables accurate simulations of building design performance.

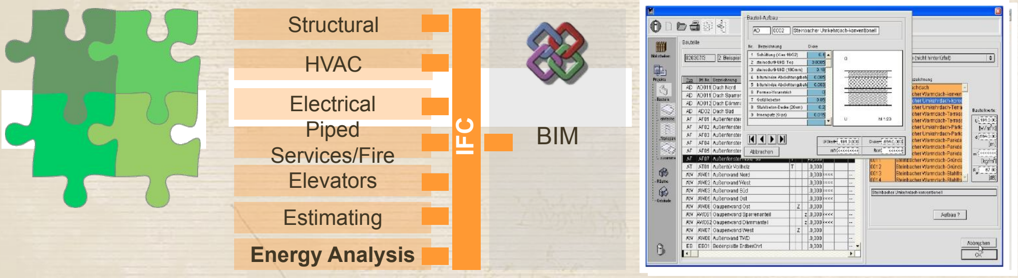


BIM Is a Catalyst for Collaborative Sustainable Design



BIM as Collaborative Foundation

- Intelligent building model
- IFC (INDUSTRY FOUNDATION CLASS)- Seamless sharing and exchange of 3D model’s information for generating building simulations
- Strategic partnership and cooperation with analysis software vendors



BIM

- Structural Engineering
- Collision Detection
- Code Checking
- Building Performance and energy simulations

What is a model?

A model is a representation of something else.

A model is useful if it is able to:

- Explain past observations.
- Predict future observations.
- Help control future events.
- Deliver value at a relatively low cost, especially in combination with other models.
- Be easily proven to be false or inaccurate.
- Present simplicity, or even aesthetic appeal.

Who is the typical building simulation client?

ARCHITECTURAL

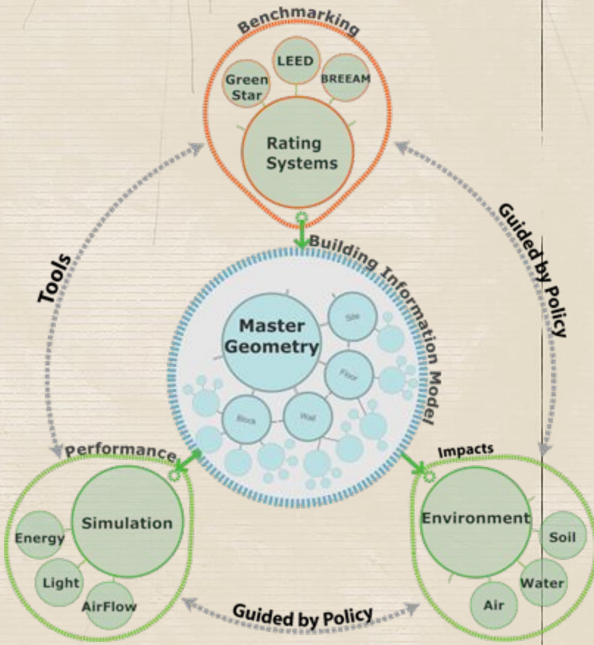
- Designers
- Architects
- Master planners
- Urban designers
- Interior Designers

ENGINEERS

- HVAC
- Mechanical
- Electrical
- Building Physics

rating systems

- Egyptian Green Building
- BREEAM
- LEED
- DGNB
- Estidama
- Gsas
- Other “green” rating   systems



Rating systems, that are used to evaluate and benchmark sustainability, are constantly evolving

Adoption of "sustainable building rating systems offer a **roadmap** that lead to sustainability goals and help align requirements"



Why BIM ,,Benefits of BIM,,

BIM for what?

- Decision making
- Rating compliance
- Building Performance

How?

- 3d visual information
- Numerical information
- Data linking transfer
- REM   Rapid Energy Modelling
- Analysis
- Cloud computing



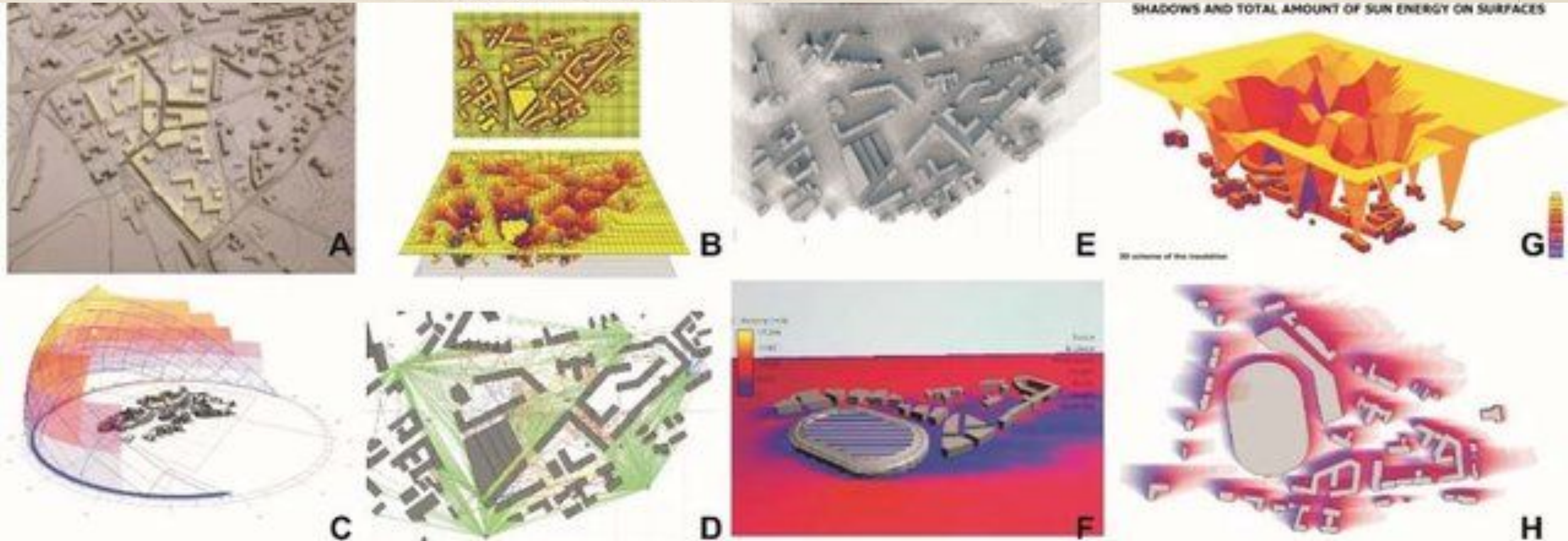
- Building location
- Building orientation
- Water use reduction
- Outdoor air delivery monitoring
- Increased ventilation
- Thermal comfort

BASIC ENERGY STUDIES AT CONCEPTUAL DESIGN STAGE INCLUDE:

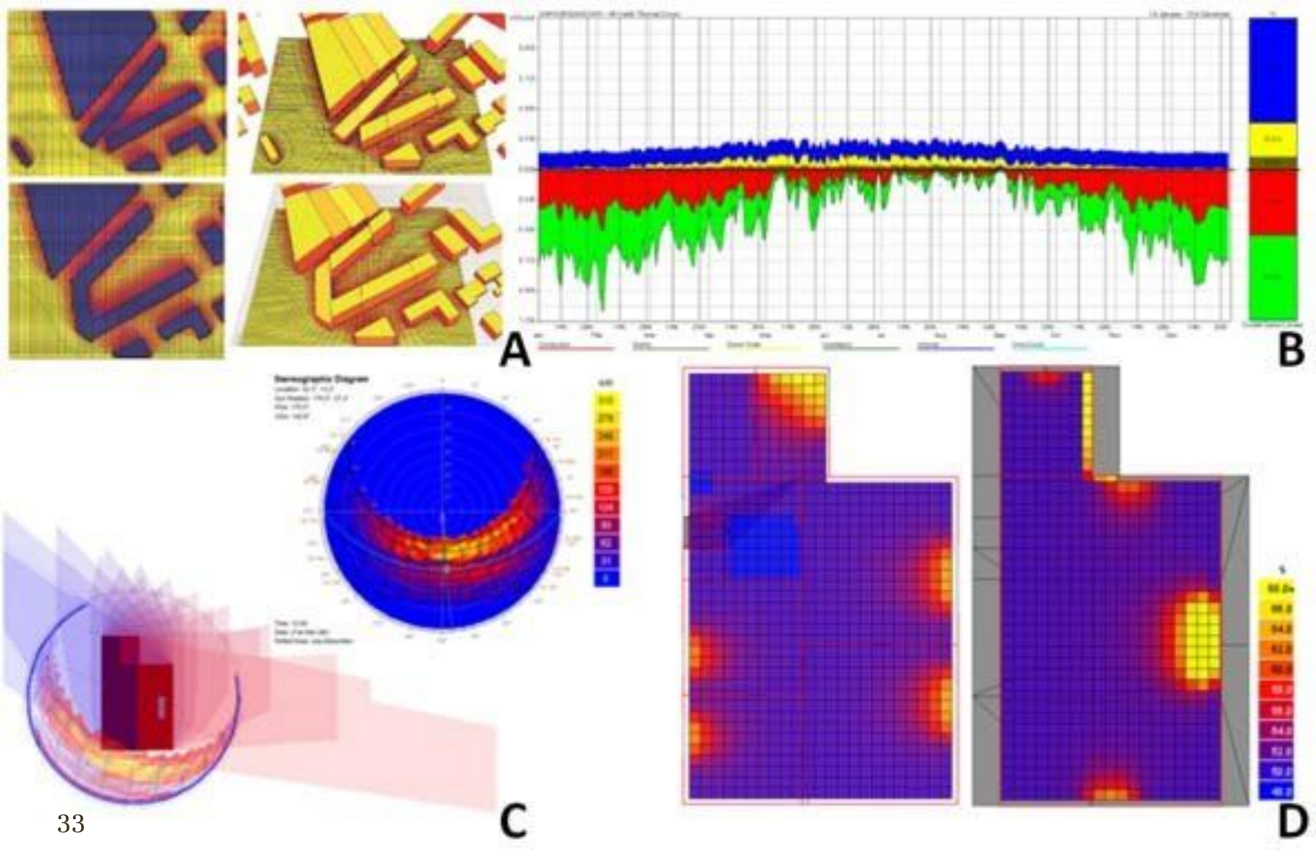
- Sun and shadow
- Wind / natural ventilation
- Solar loads / radiation
- Building envelope performance
- Heating & Cooling loads
- Daylight availability
- Whole building energy use & costs
- Water use & costs (indoor, outdoor, and catchment)
- Carbon emissions

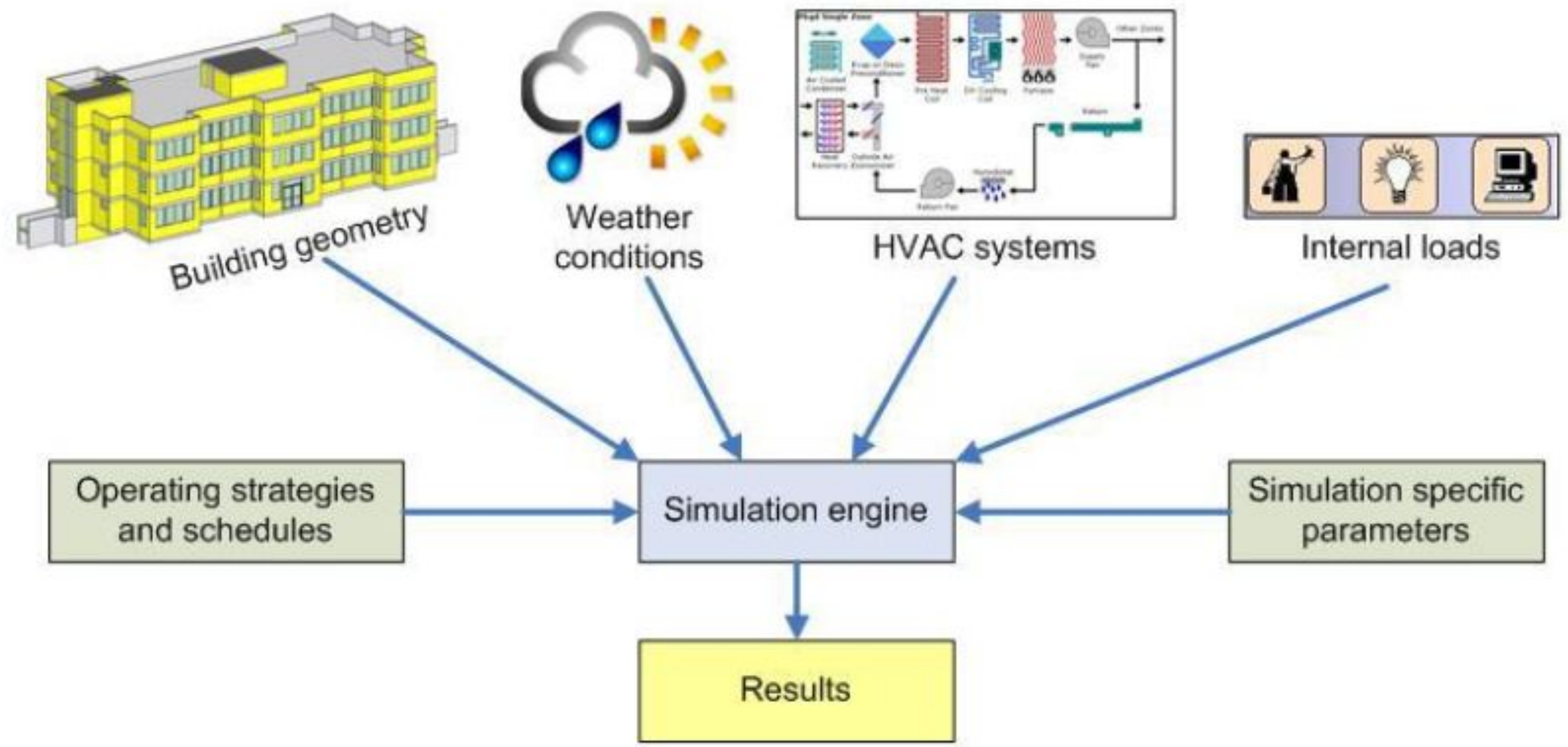
- Lighting analysis
- CFD analysis
- Fire analysis
- Solar/shading analysis
- Energy code compliance
- Thermal comfort
- Heating and cooling load analysis
- LCA Life Cycle Assessment
- Renewable energy
- HVAC equipment sizing

A. Physical model,
B. Model transposition to the software,
C. Sunlight analysis on surfaces determine the amount of passive energy,
D. Sound/noise analysis,
E. Analysis of the year shadow range,
F. Wind analysis,
G. Shadow analysis taking into account the annual passive energy distribution,
H. Colorful of the shadow range.

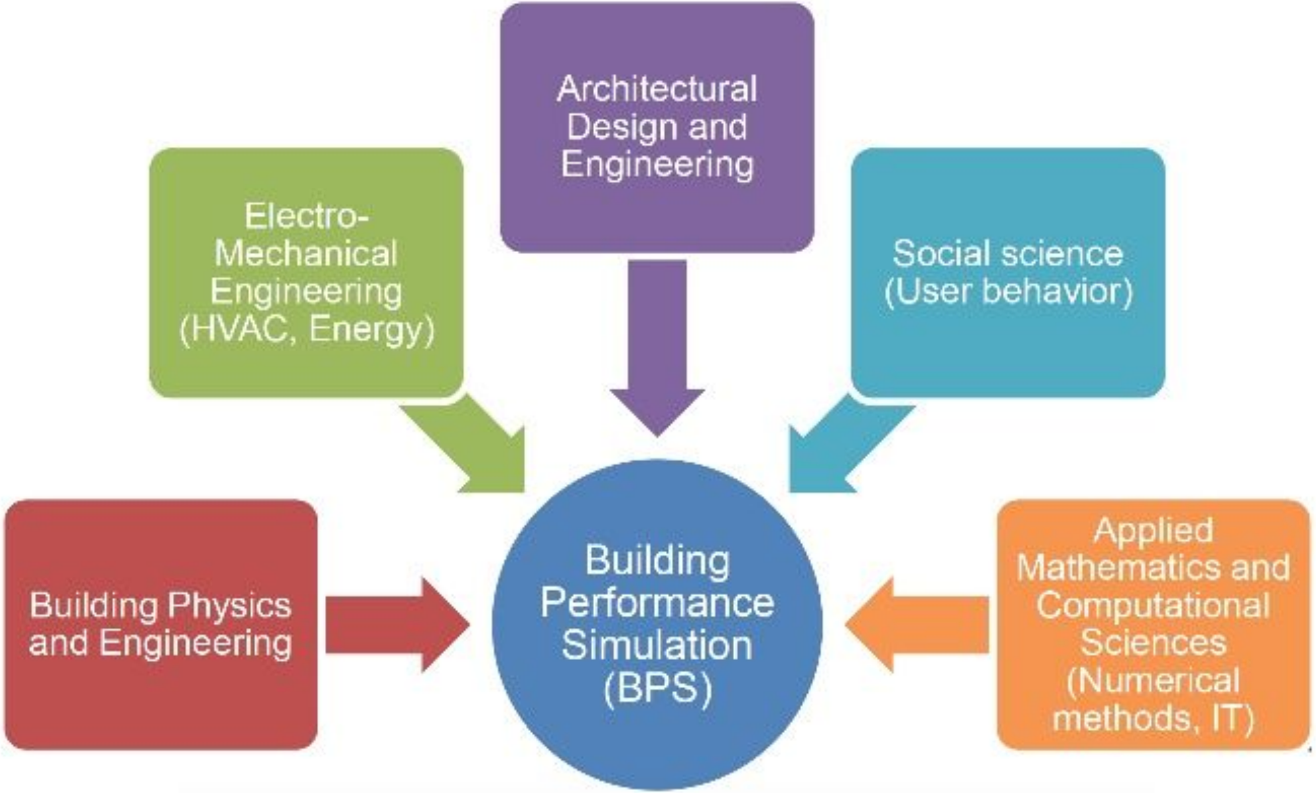


Results from BIM software analysis.
A. Shading analysis of surface sun exposure which attempts to re-design object structures;
B. Thermal analysis-passive gains;
C. Shadow range and sun exposure;
D. Internal solar access.

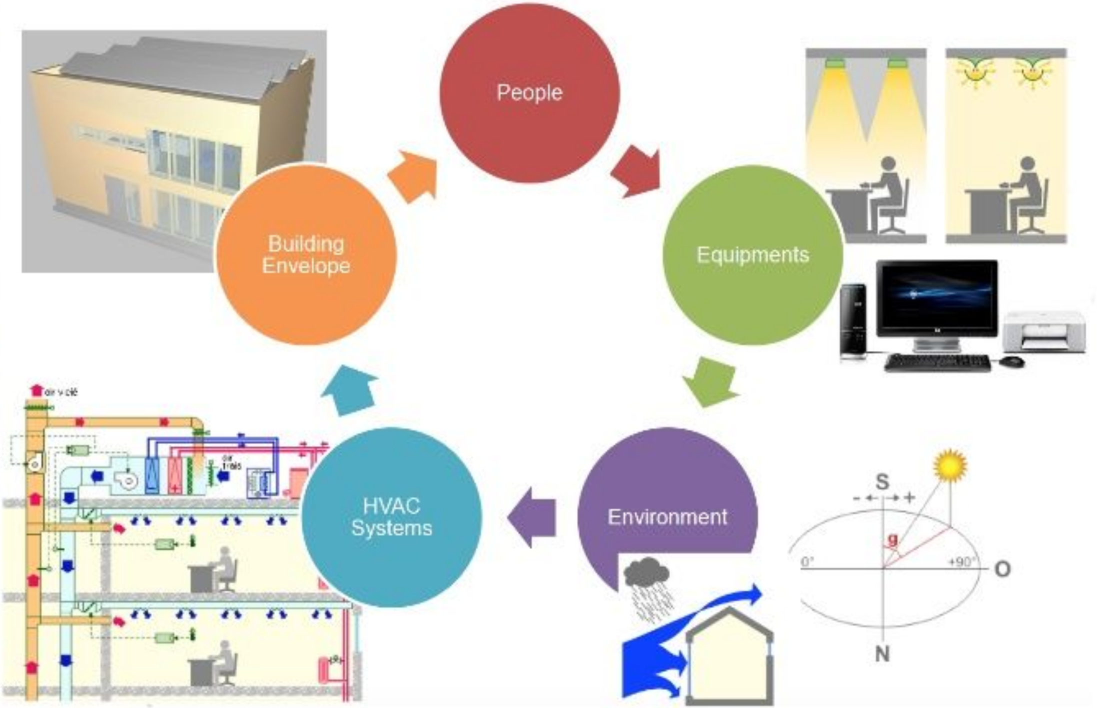



Building geometry
Weather conditions
HVAC systems
Internal loads
Operating strategies and schedules
Simulation engine
Simulation specific parameters
Results

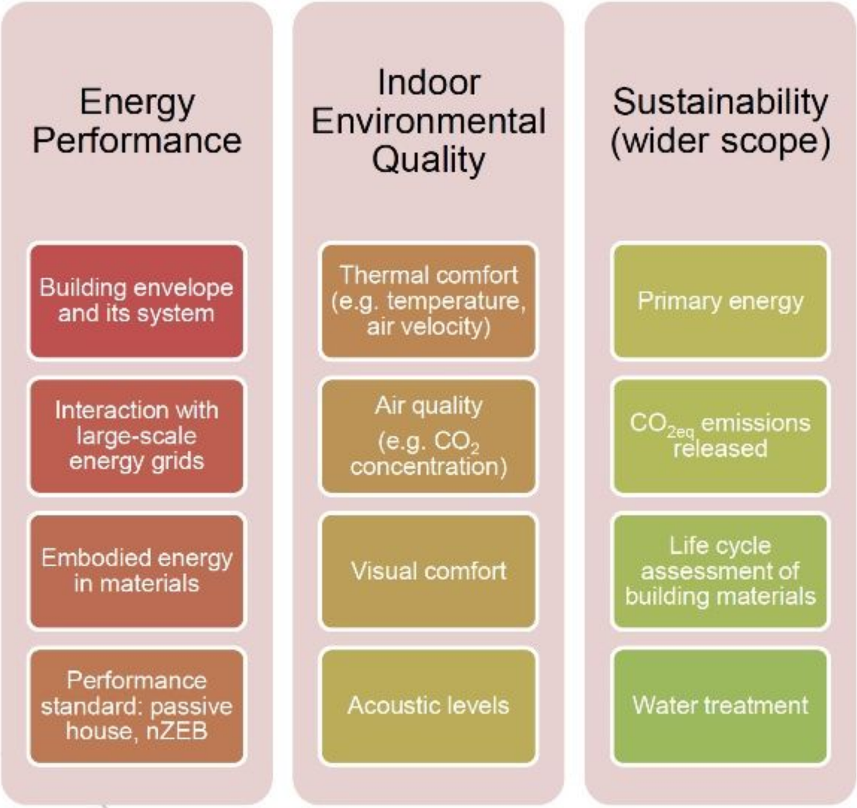
BPS discipline is multi-disciplinary



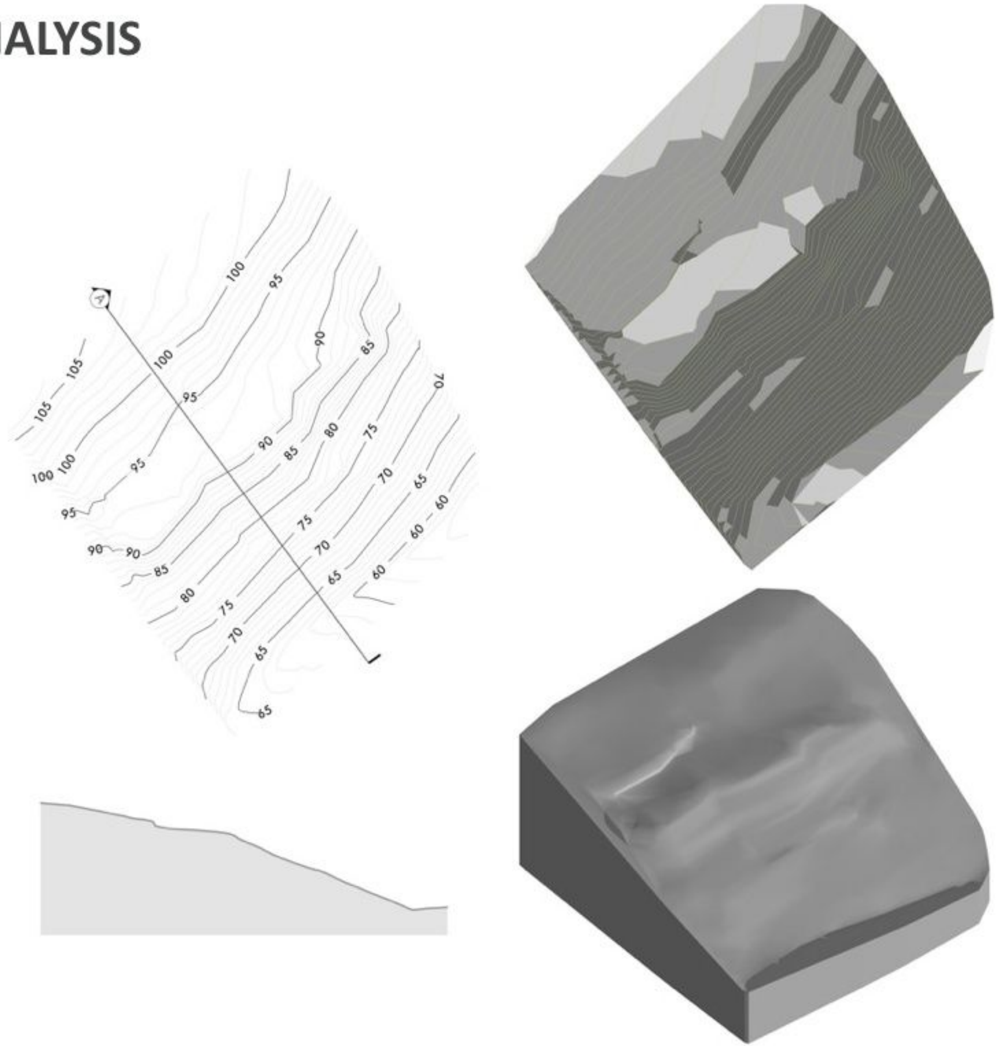
BPS simulates complex coupled systems



BPS is multi-objectives



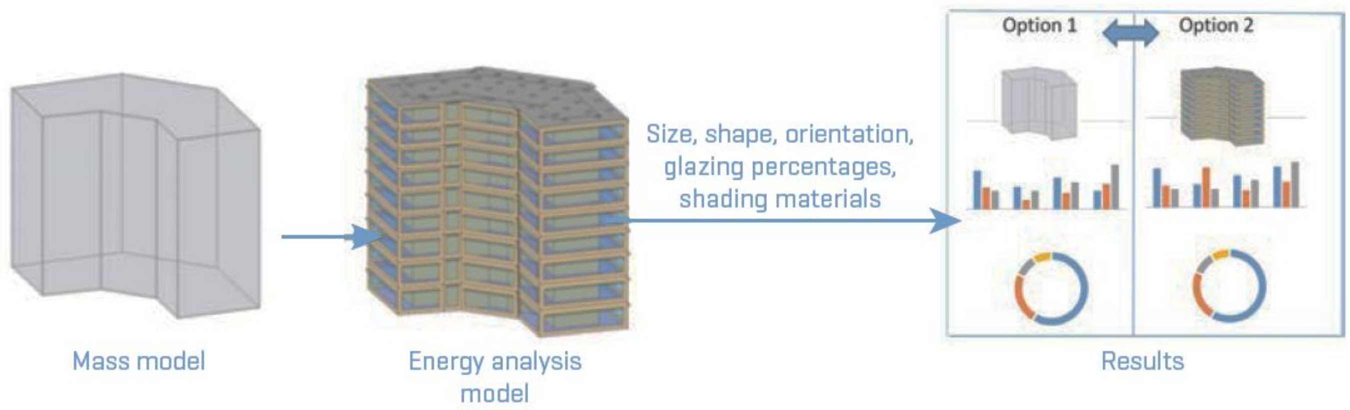
SITE ANALYSIS



Energy Modeling

- Using BIM in the design process helps us evaluate energy efficiency and make recommendations for design alternatives that will enhance a building's performance. By combining BIM with specialized energy modeling software, every part of a building, from MEP (Mechanical, Electrical & Plumbing) systems to interior climate, can be simulated and optimized for energy efficiency.

Figure 46: Sustainability analysis using mass models



Carbon

- Carbon footprinting with BIM helps us test conceptual designs so we can specify solutions with the lowest carbon impact. This allows us to identify low carbon options that have the potential to drive down carbon emissions during the design and construction phases, as well as options that lead to carbon savings during a building's operation.

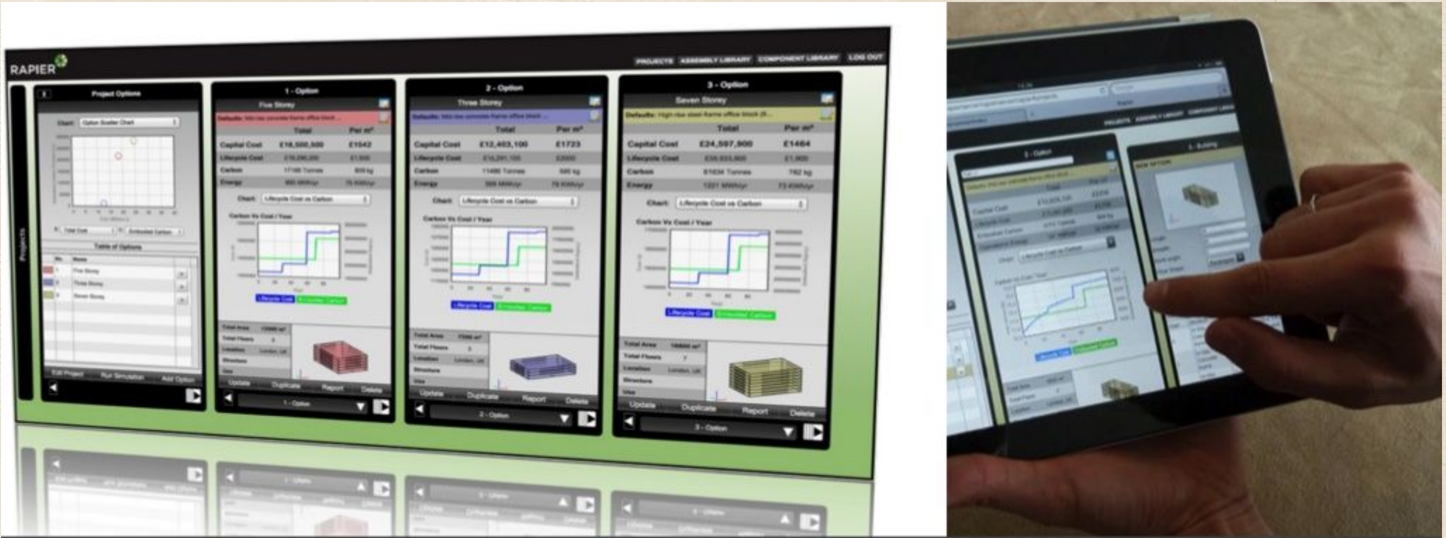
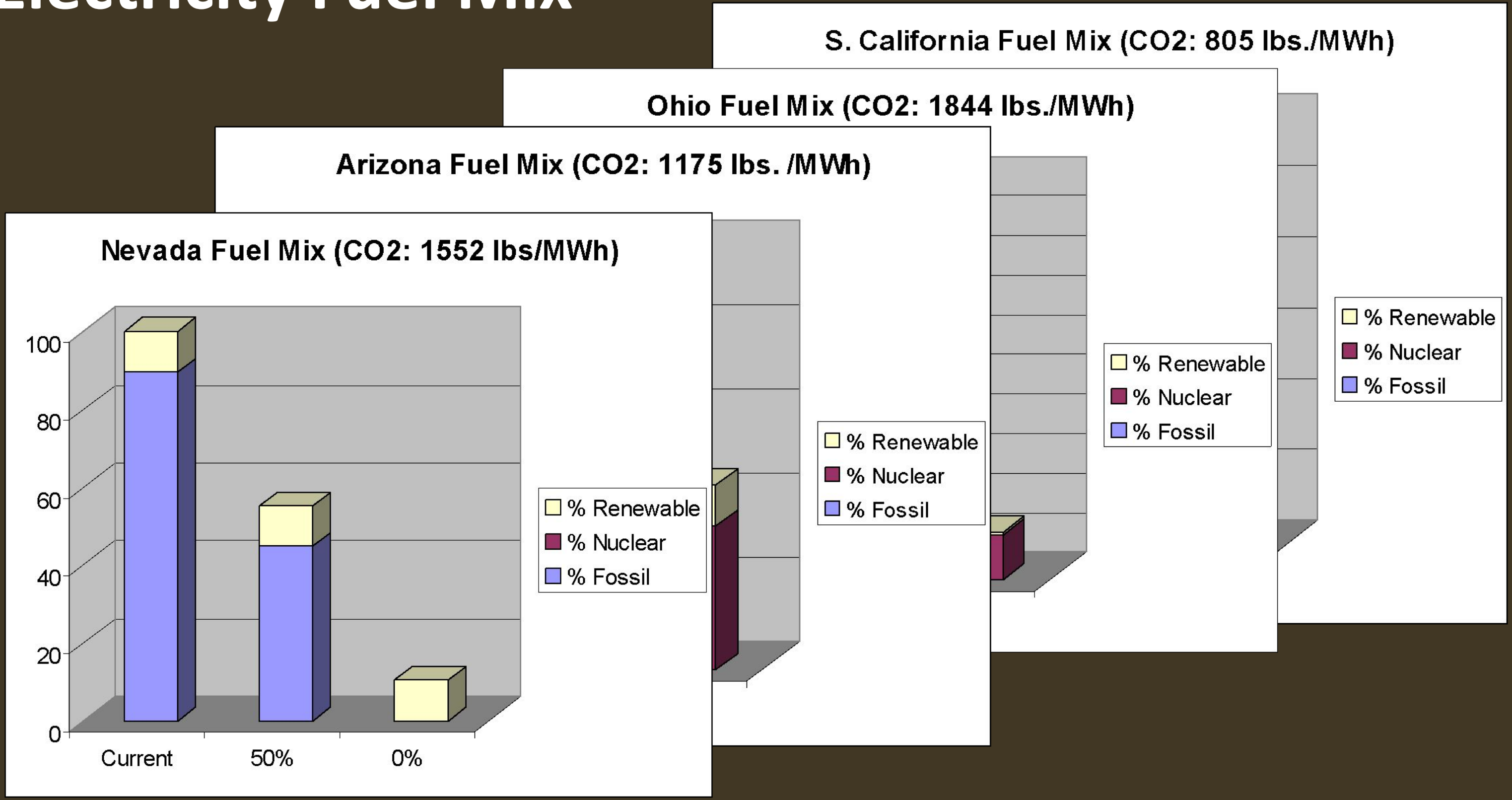


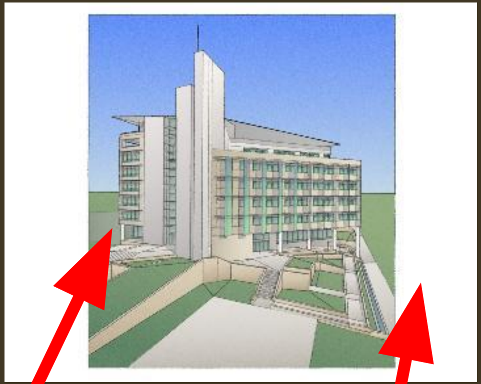
Image: rapiere.net Declaration: Architype are one of the founding partners of Rapiere

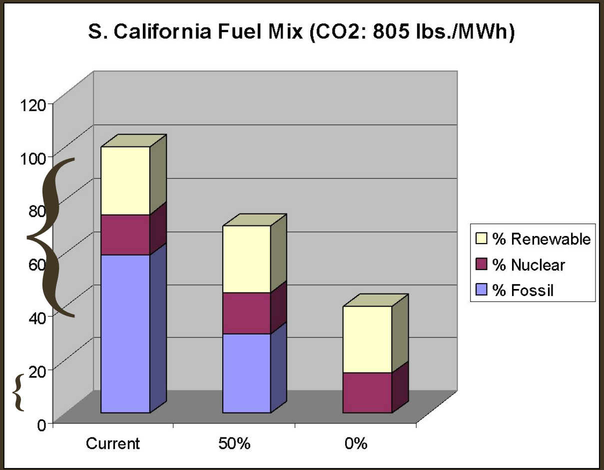
Carbon Footprint Varies - Regional Electricity Fuel Mix



A Carbon Neutral Building – Simple Example

Requires a Very Efficient Building





40% non-carbon

60% reduction in grid electricity

Onsite Renewable Generation

Biofuel Diesel Generator or Boiler

Grid Electricity

Materials

- Tying BIM to materials can significantly reduce construction waste and streamline the supply chain through more accurate procurement. Like carbon footprinting, it also helps us select design solutions that can reduce the overall environmental impact of a building throughout its operation. While BIM has the potential to reduce waste on all construction projects, it is highly beneficial to large complex projects, which tend to generate significant waste if they are not carefully managed.

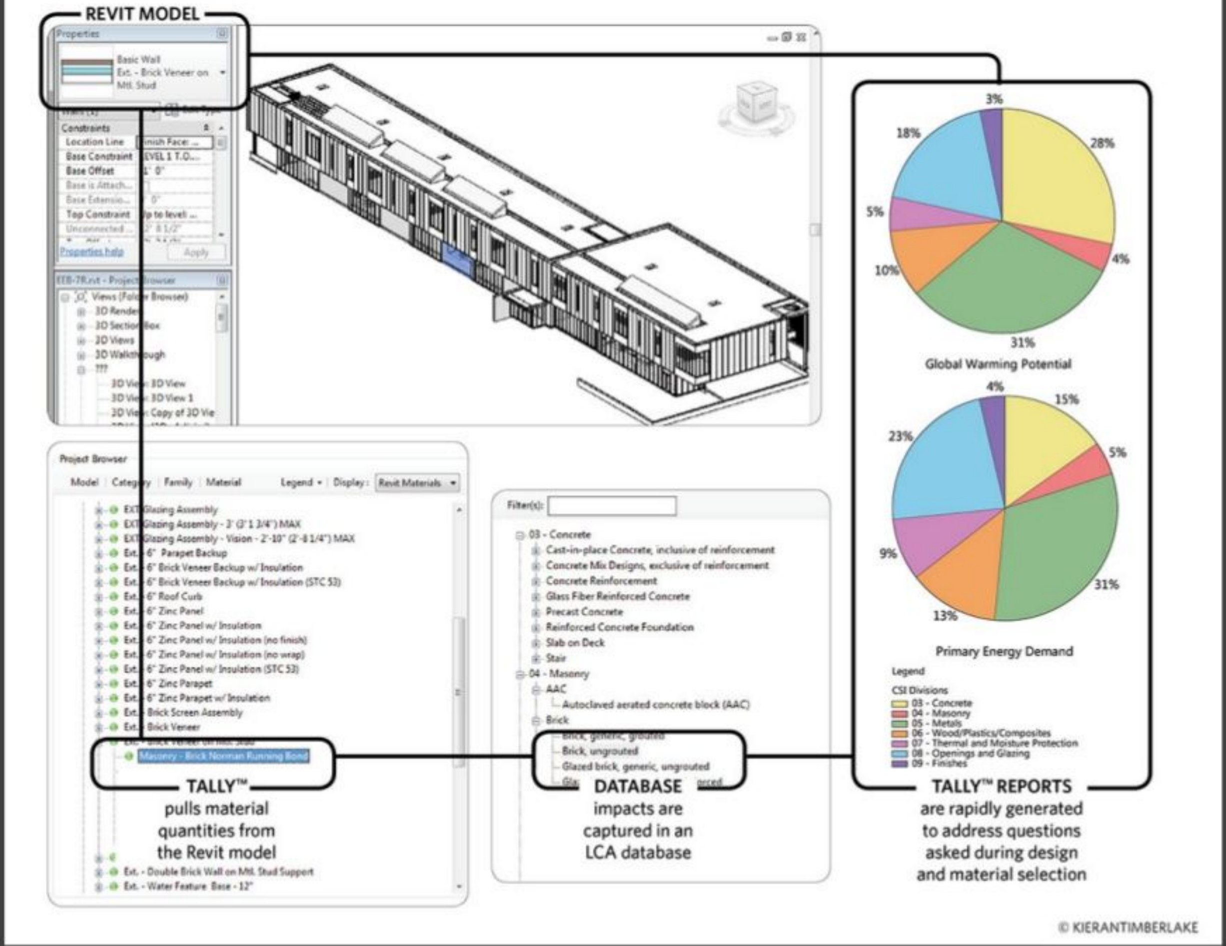


Image: www.kierantimberlake.com

BREEAM Mat 1 Takeoff		
Material Name	Volume (m3)	Green Guide Rating
Brick - Bushbury	54.70	A+
Concrete - Cast In Situ	348.94	B
Finishes - Interior - Fermacell	4.68	A+
Insulation / Support Frame	12.00	A
Insulation / Thermal Barriers - Batt insulation	61.10	A
Insulation / Thermal Barriers - Cavity Fill	506.20	A
Insulation / Thermal Barriers - External Wall Insulation	210.16	B
Insulation / Thermal Barriers - Rigid insulation	290.78	B
Plasterboard	39.51	A+
Plastic - GRP - Glass Reinforced Plastic	1.91	B
Roofing - Metal	1.86	A



MATERIALS USE







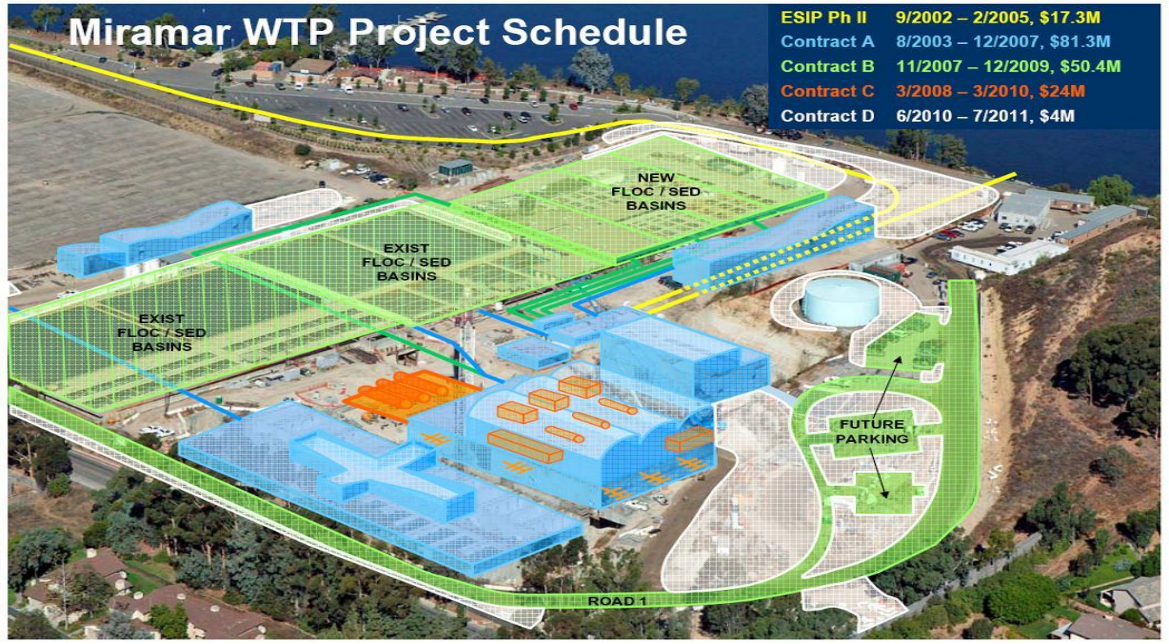
Bley Sleeping House Addition by Agruppo. BIM model and photos by Andrew Nance.

Water

- BIM helps to quantify the amount of water used in a building by calculating the number of fixtures (sinks, toilets, etc.) and their related water usage. This also helps us measure the potential for greywater reuse, which is highly beneficial for reducing demand on local water supplies. The amount of water available for harvesting can be calculated using BIM, based on the site, harvesting system, and the size of building.

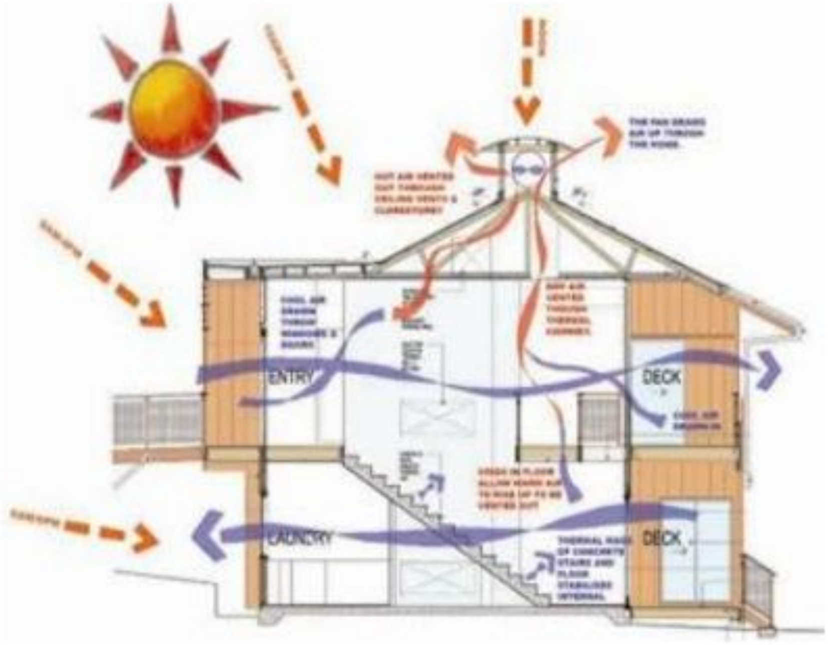
What are the main sustainability challenges that society faces today?

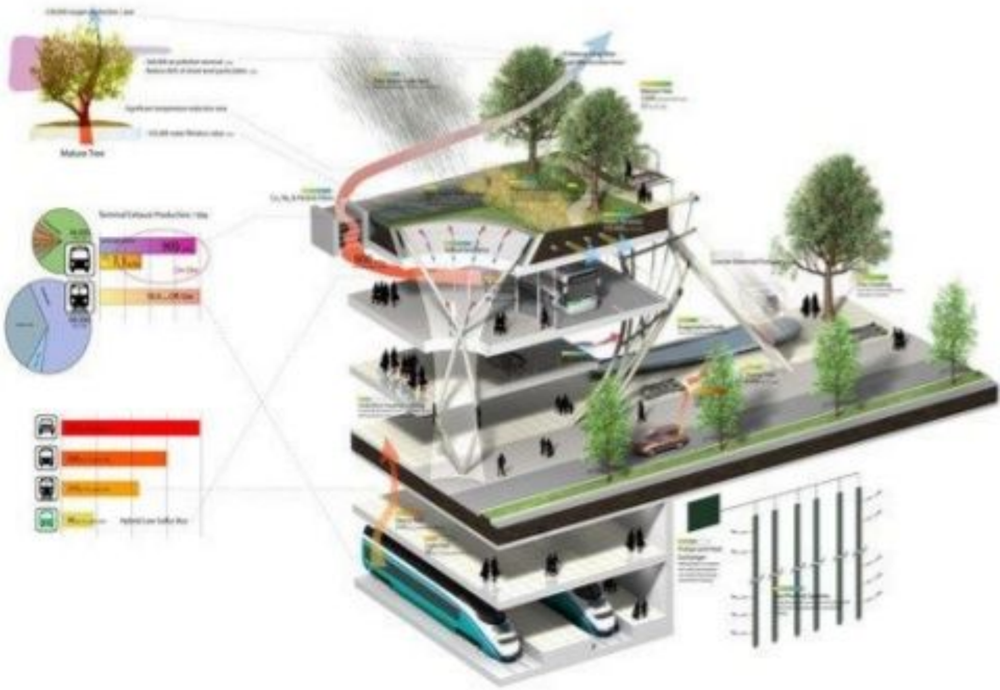
Maintaining and Expanding Access to Fresh Water



Aerial map of Miramar Water Treatment Plant Project with contract phase overlays, by L. Robin, 2009, courtesy The City of San Diego, California

Sustainable architecture is integrating two aims include Technology and human’s aim

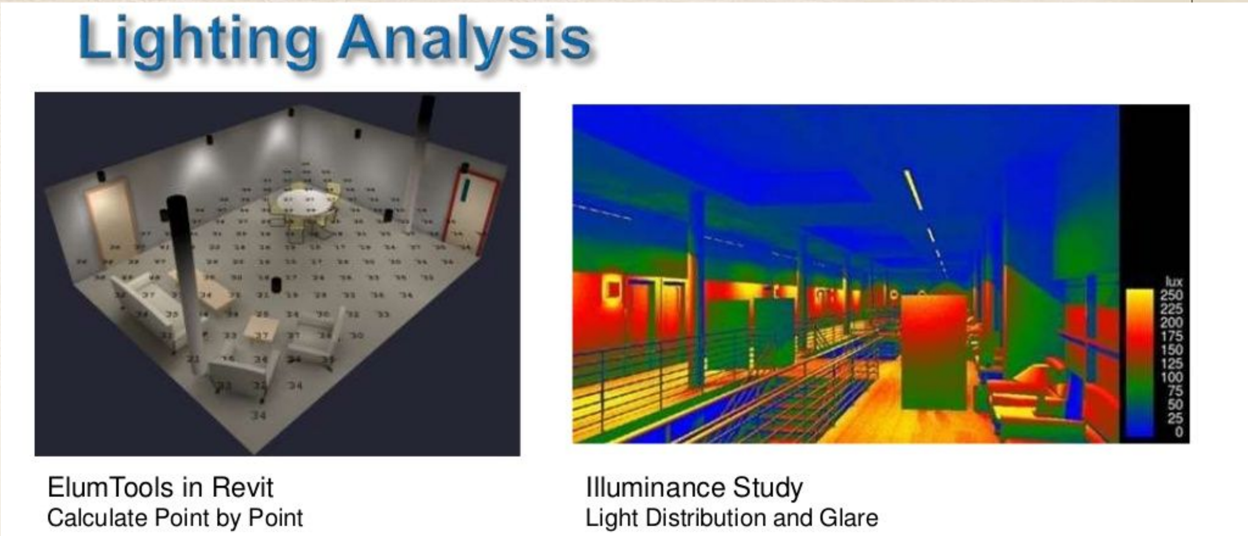




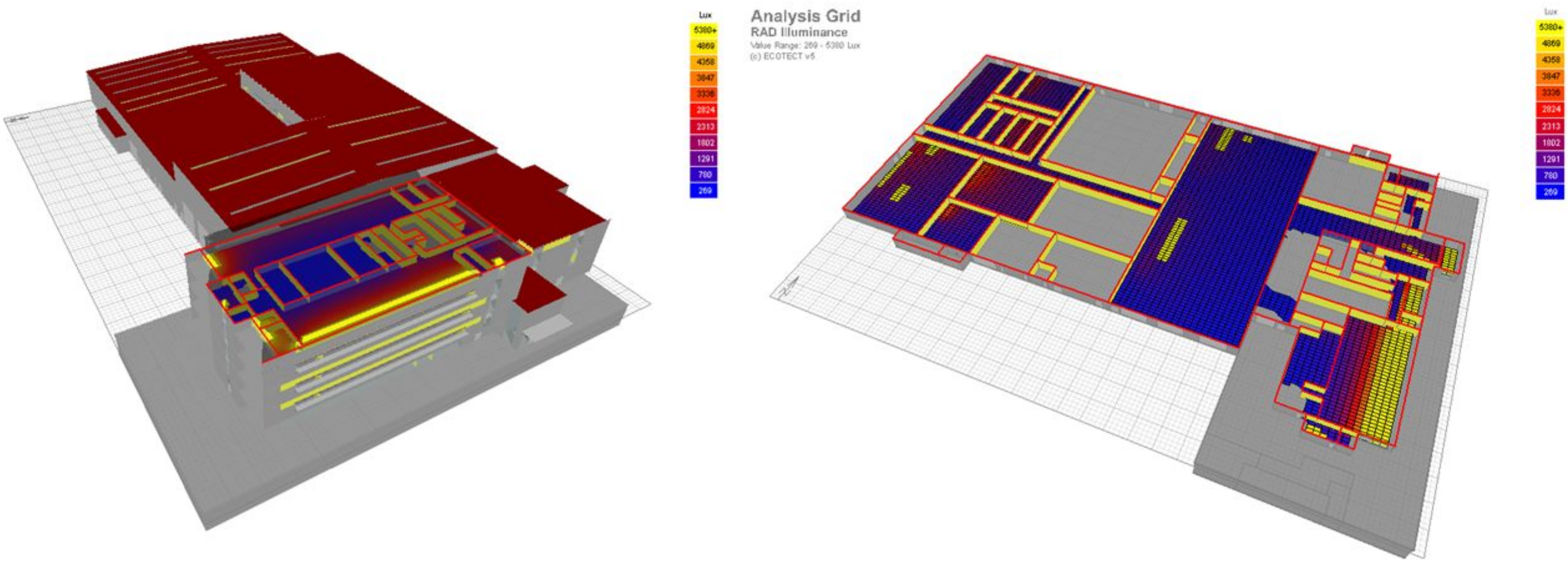
Artificial lighting

The simulations allow to calculate a series of climate-based daylight metrics such as:

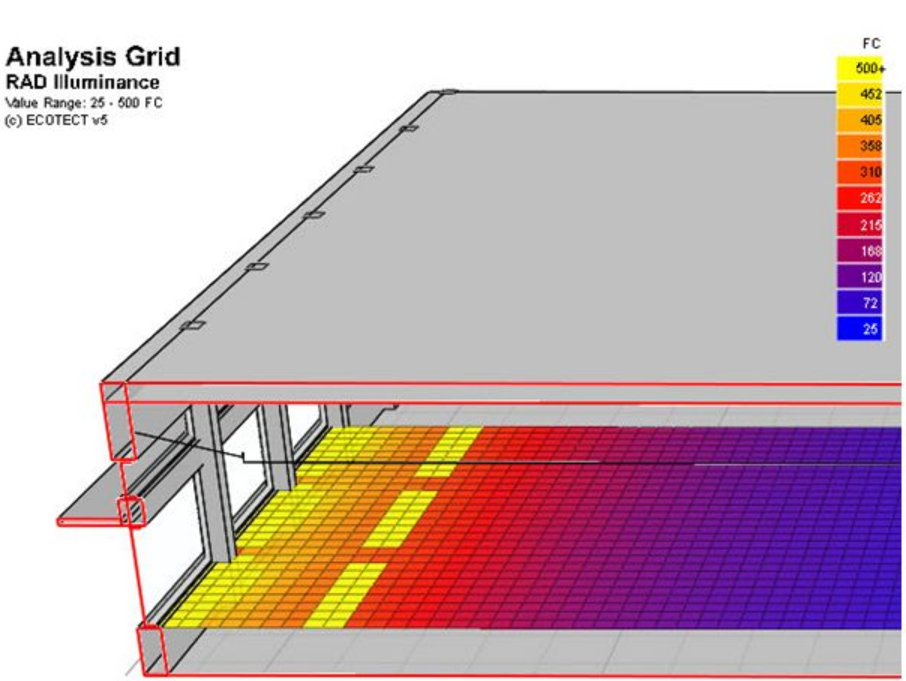
- Daylight Autonomy (DA)
- Useful Daylight Illuminance (UDI)
- Daylight Glare Probability (DGP)
- Daylight Factor (DF)

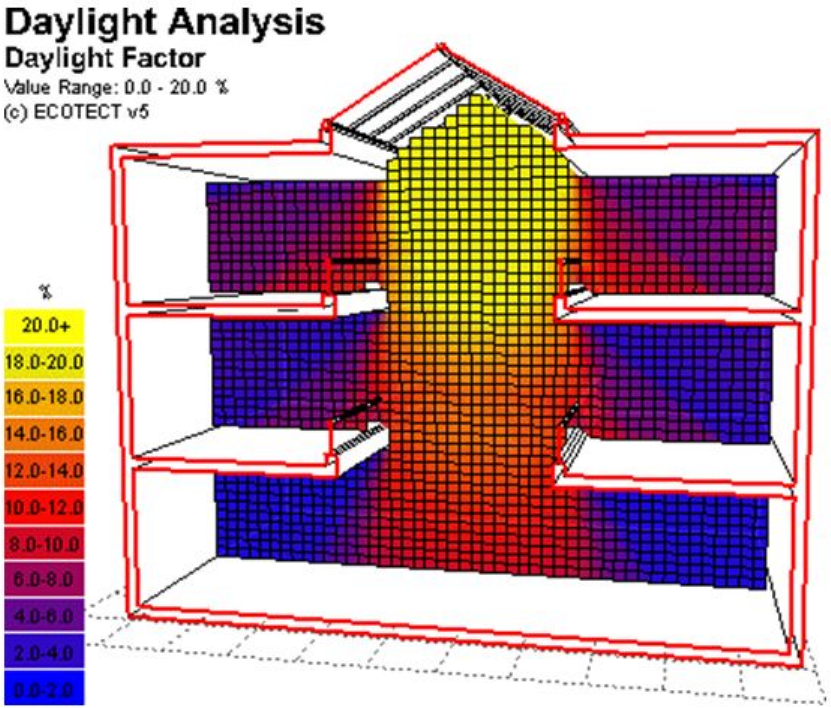


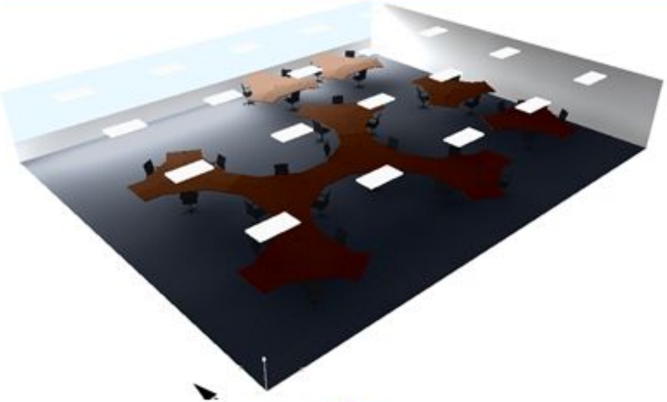
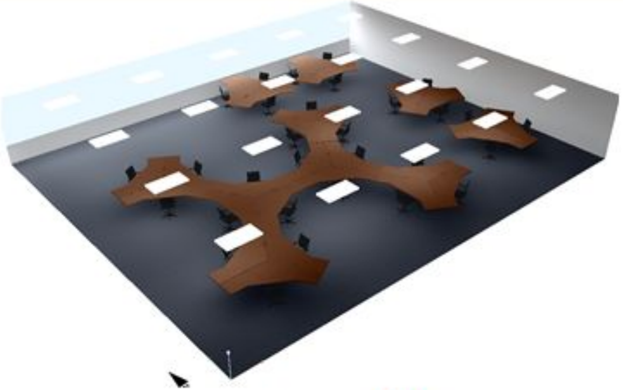
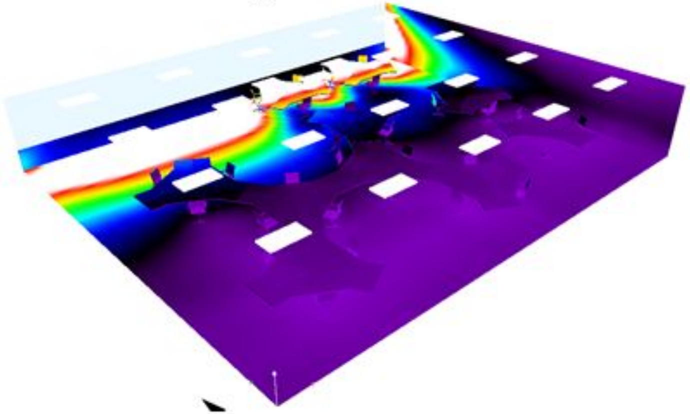
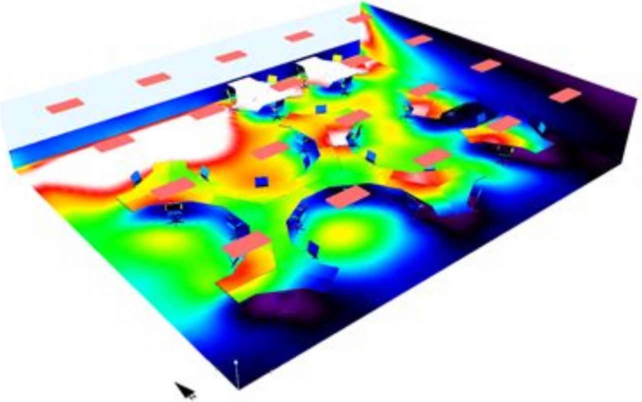
Daylighting Modeling –3D View



Daylighting simulation extract



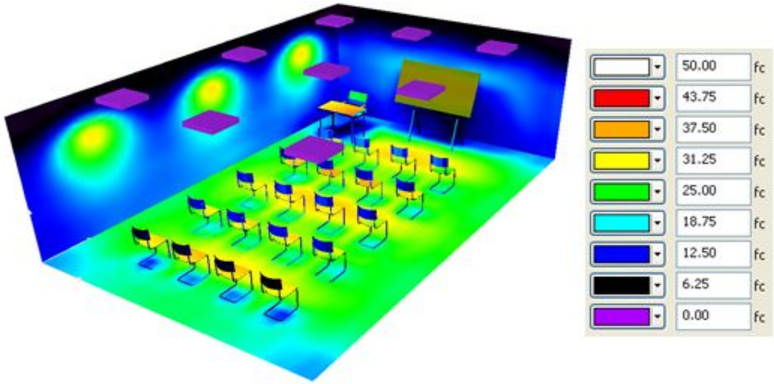


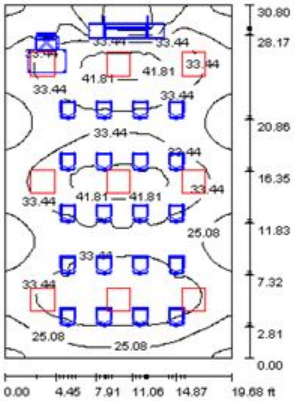
North-facing window	North-facing window + **skylight** (about 20m^2)
	
	

→Recommend to install skylight above regularly occupied spaces in the office 2nd floor

Training Room Lighting





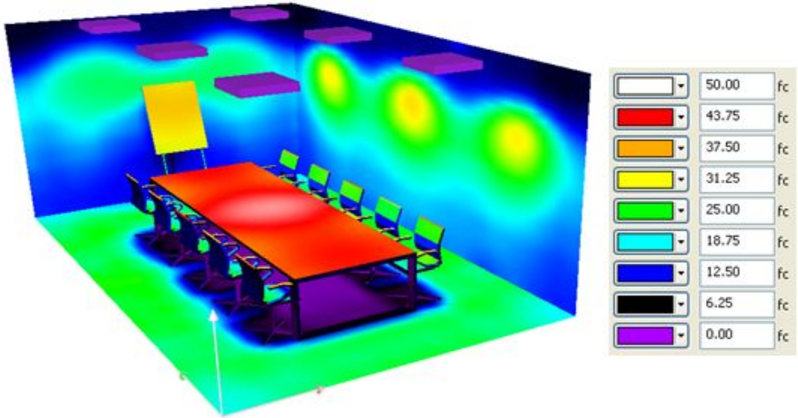


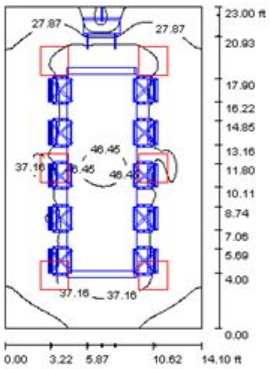
Lighting Design Example			
Fixture type	Quantity	Power (W)	Average Illumination (lux)
3x14 W	9	432	330

→ Installed LPD = **7.6 W/m²**

Meeting Room Lighting





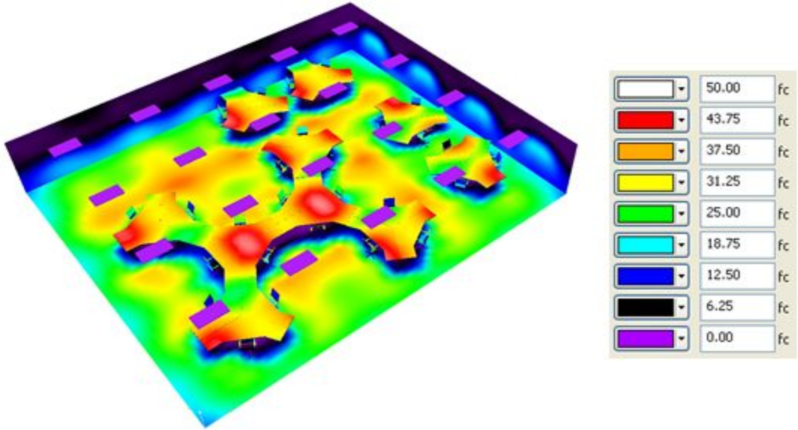


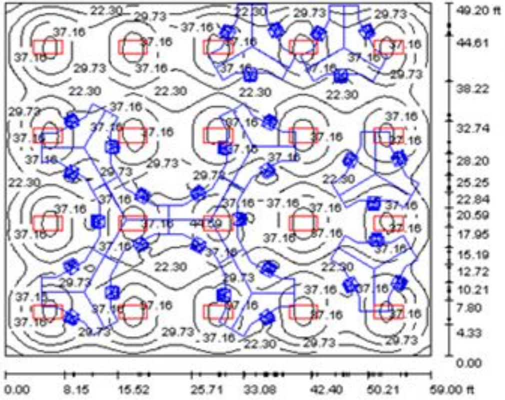
Lighting Design Example			
Fixture type	Quantity	Power (W)	Average Illumination (lux)
3x14 W	6	288	375

→ Installed LPD = **9.5 W/m²**

Open Office Space Lighting







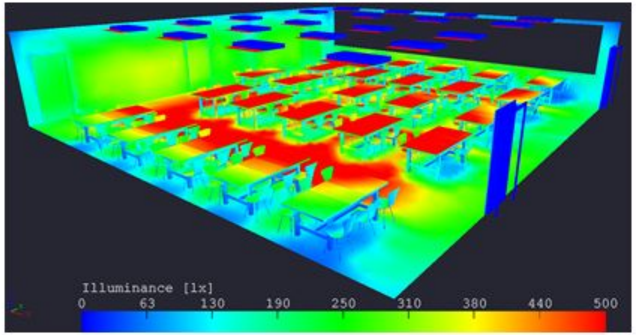
Lighting Design Example			
Fixture type	Quantity	Power (W)	Average Illumination (lux)
3 x 28W	20	1880	350

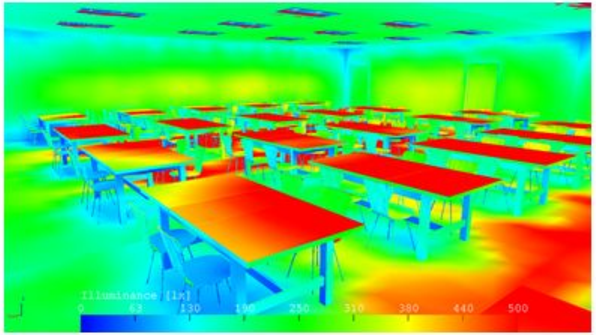
→ Installed LPD = **7.0 W/m²**

Canteen Lighting

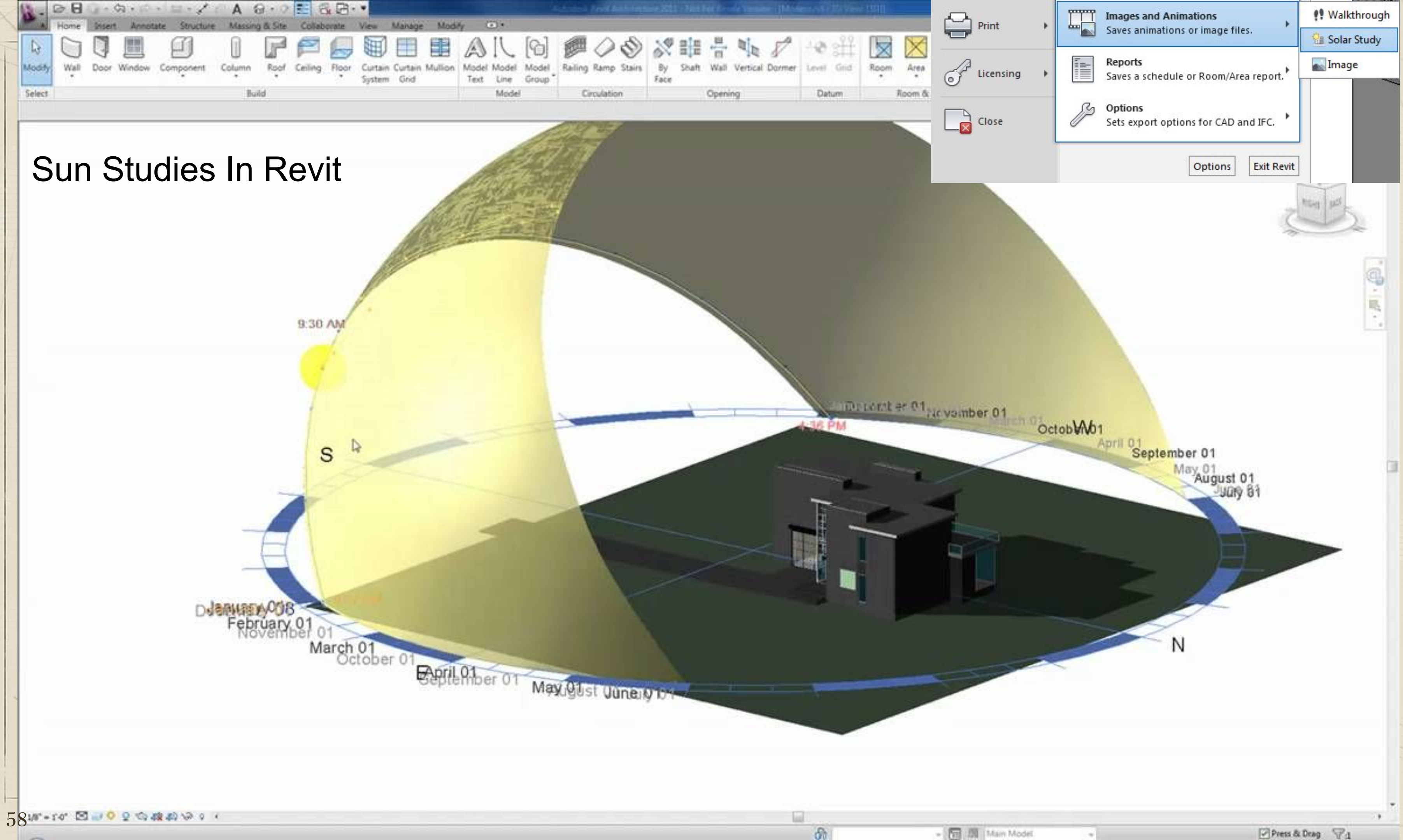




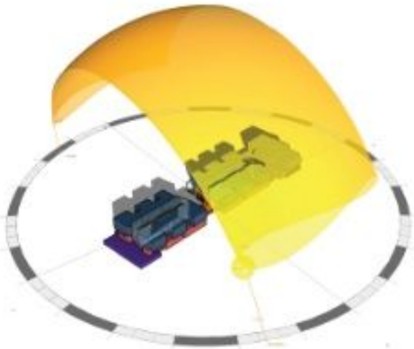




Sun Studies In Revit



Mall Skylighting Preliminary Analysis



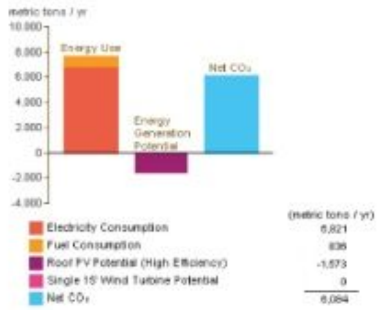
Annual Sun Exposure (8am - 5pm)

* Calculations assume 50% glazing on exterior faces throughout the rest of project, not including the theater

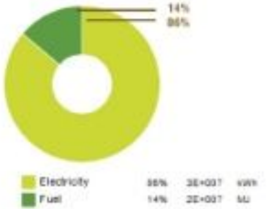
* The increase of efficiency is a percentage of the energy consumption over the entire project, not just the mall atrium spaces

95% Skylight Glazing

Annual Carbon Emissions

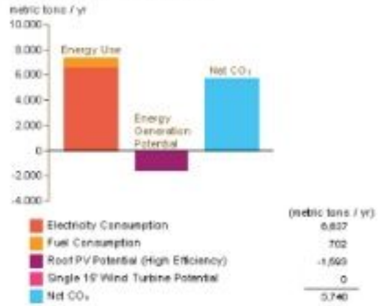


Energy Use

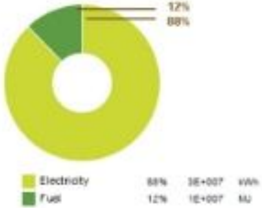


65% Skylight Glazing

Annual Carbon Emissions



Energy Use



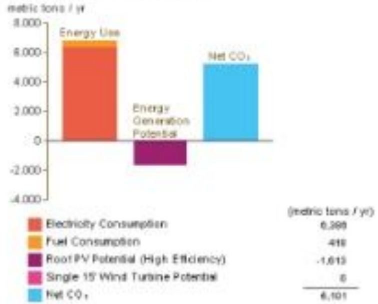
Efficiency Increase (Metric Tons /yr)

Elec. Consumption	-184 (2.7%)
Fuel Consumption	-134 (16.0%)

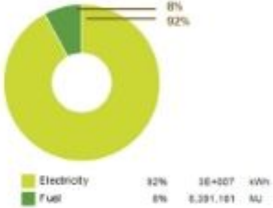
(Compared to 95% Skylight Glazing)

35% Skylight Glazing

Annual Carbon Emissions



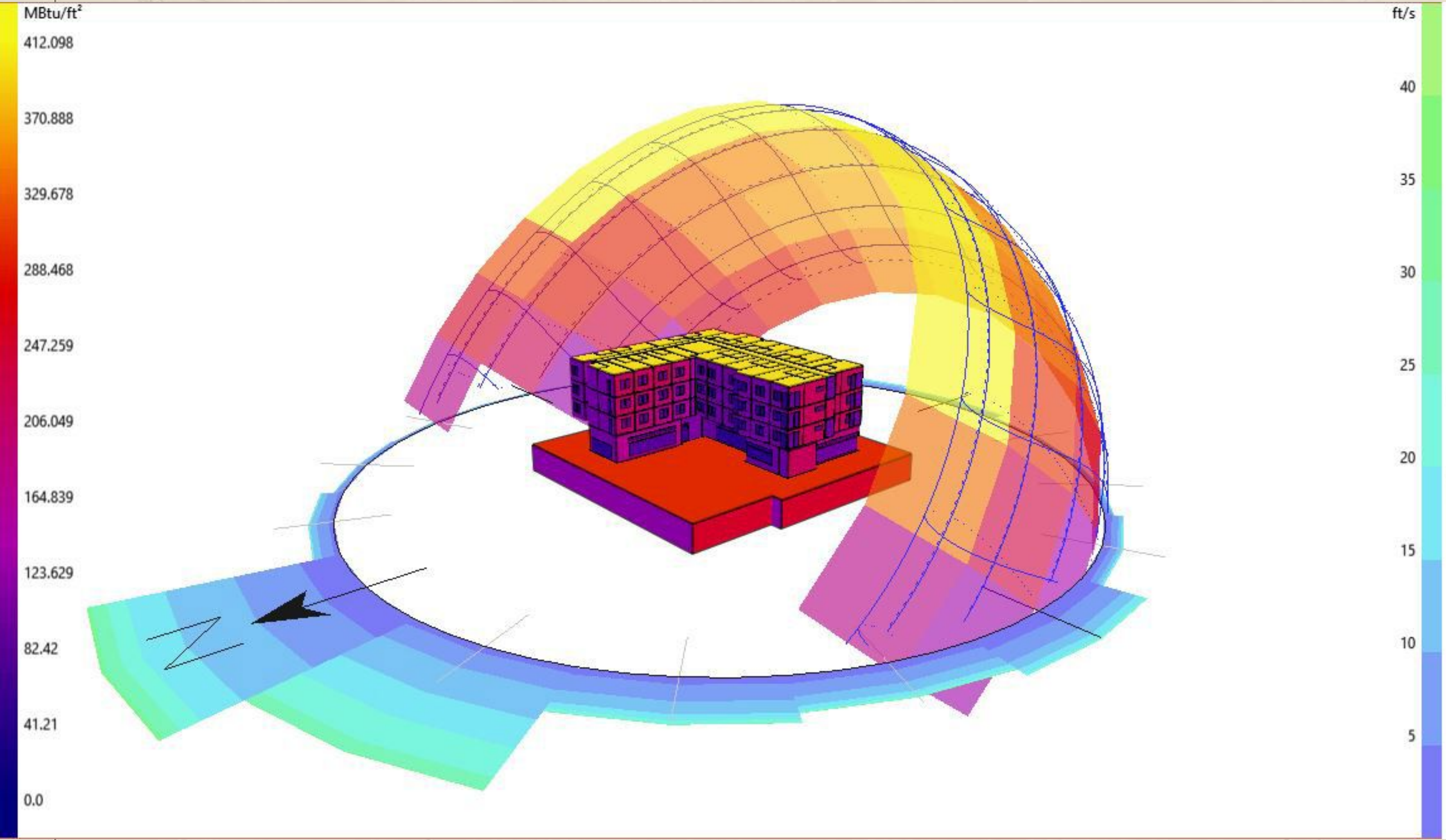
Energy Use

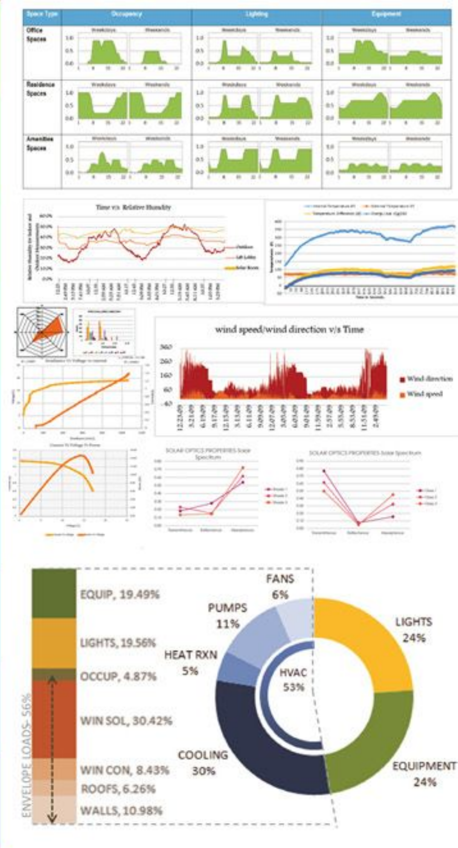


Efficiency Increase (Metric Tons /yr)

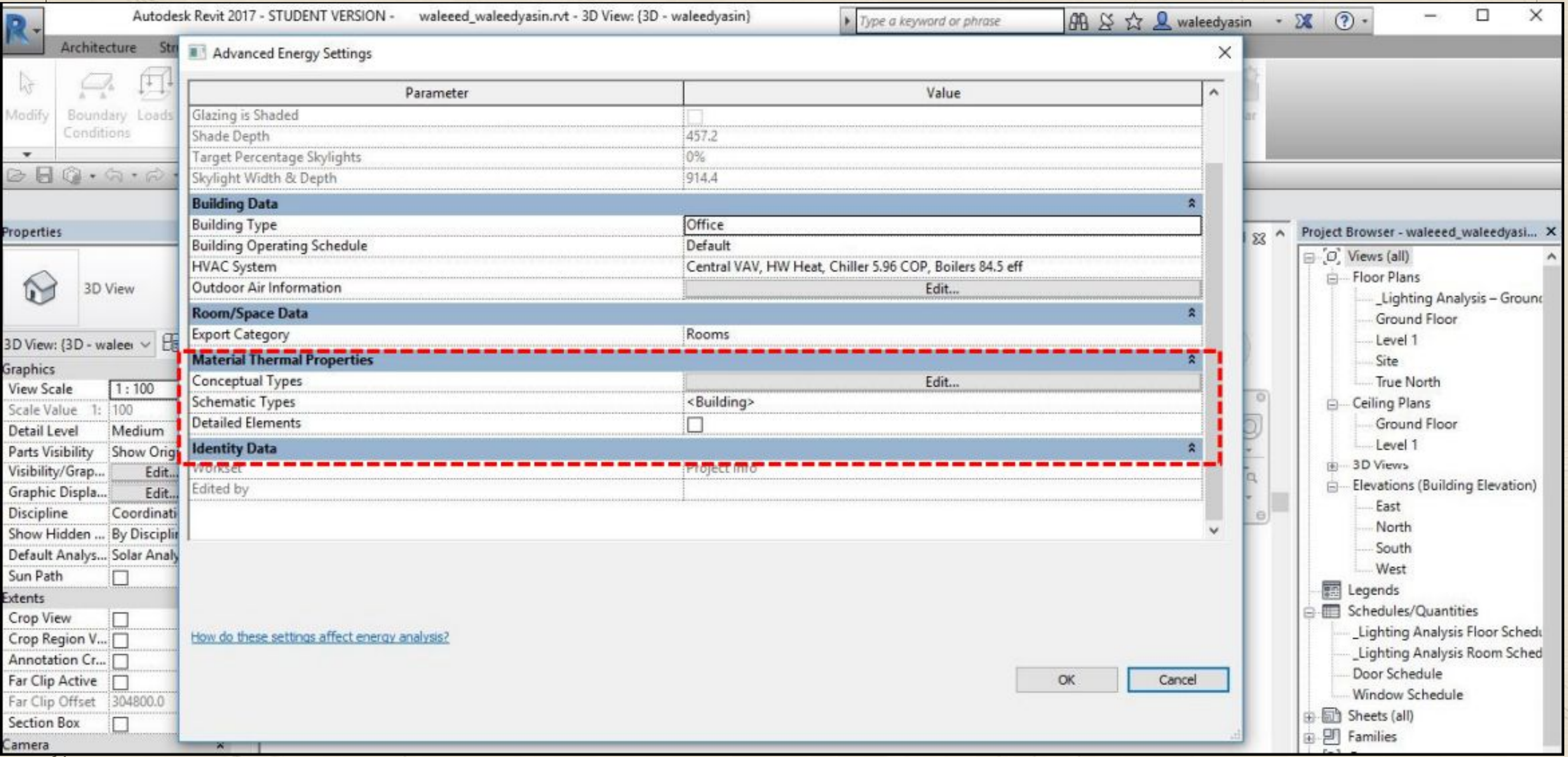
Elec. Consumption	-425 (6.2%)
Fuel Consumption	-418 (50.0%)

(Compared to 95% Skylight Glazing)

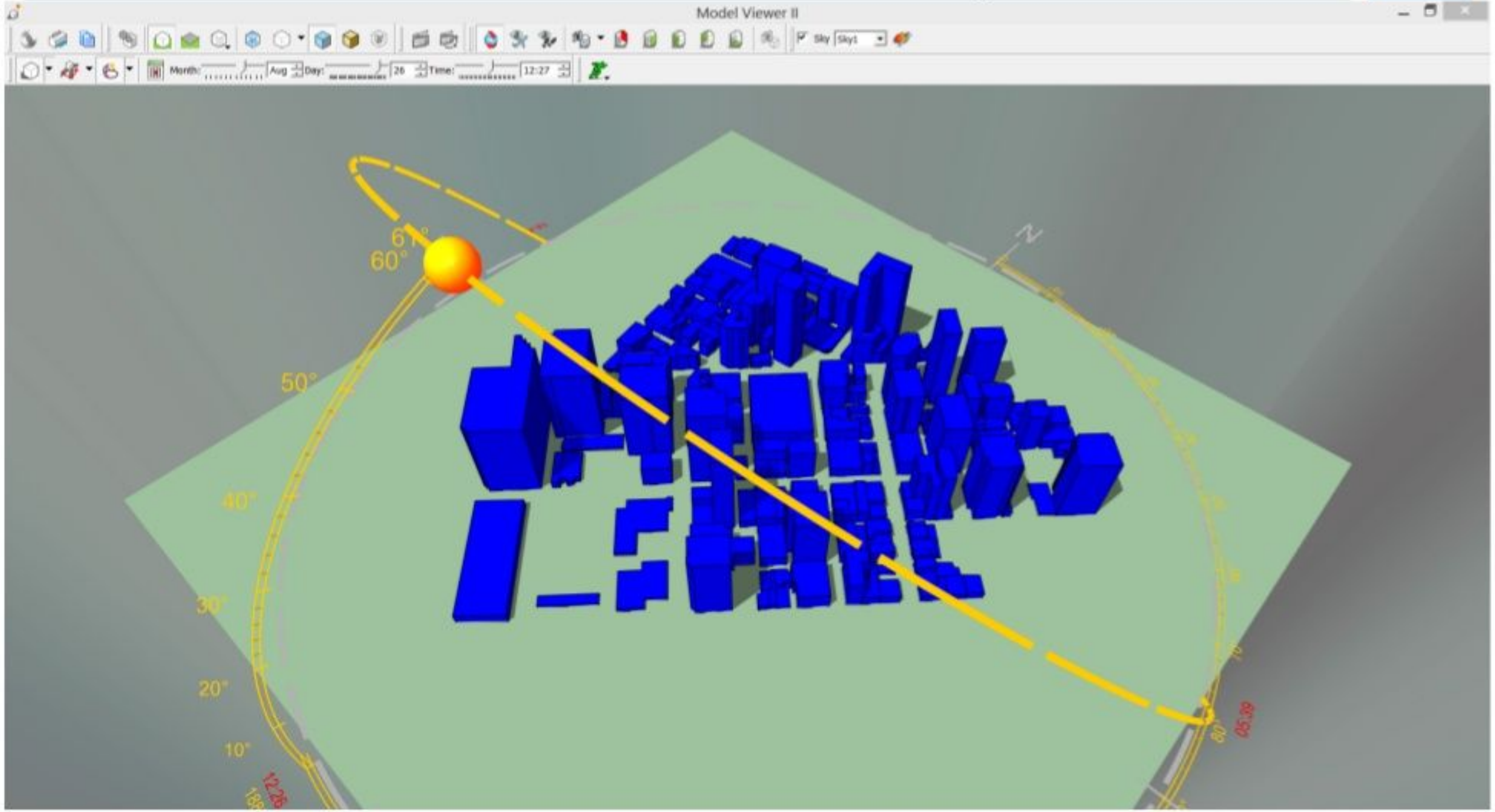

MBtu/ft²
412.098
370.888
329.678
288.468
247.259
206.049
164.839
123.629
82.42
41.21
0.0
ft/s
40
35
30
25
20
15
10
5


wind speed/wind direction v/s Time
Wind direction
Wind speed
EQUIP, 19.49%
LIGHTS, 19.56%
OCCUP, 4.87%
WIN SOL, 30.42%
WIN CON, 8.43%
ROOFS, 6.26%
WALLS, 10.98%
ENVELOPE LOADS- 56%
FANS
6%
PUMPS
11%
HEAT RXN
5%
HVAC
53%
COOLING
30%
LIGHTS
24%
EQUIPMENT
24%

REVIT PRACTICE

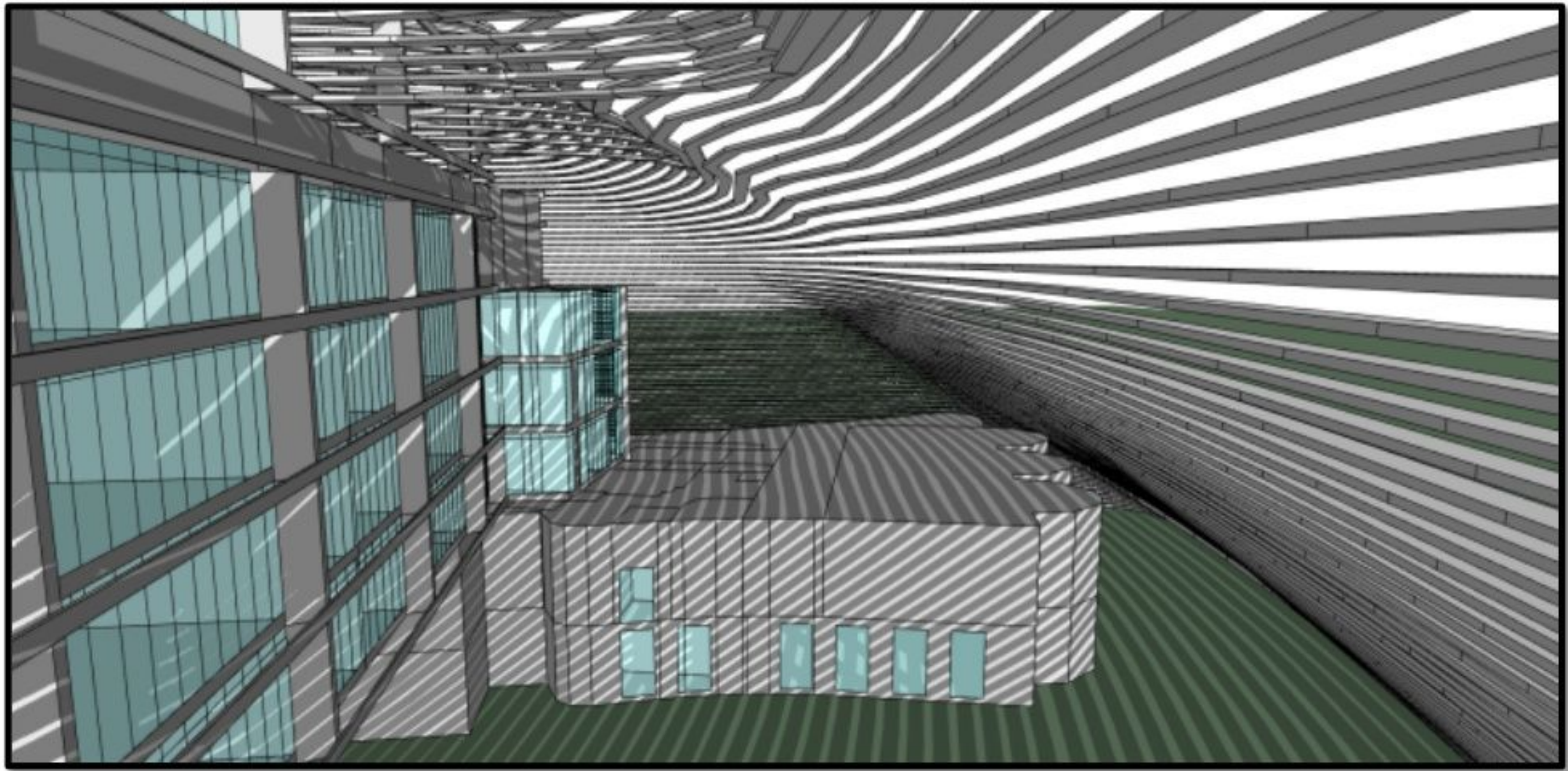


Solar Shadow Study



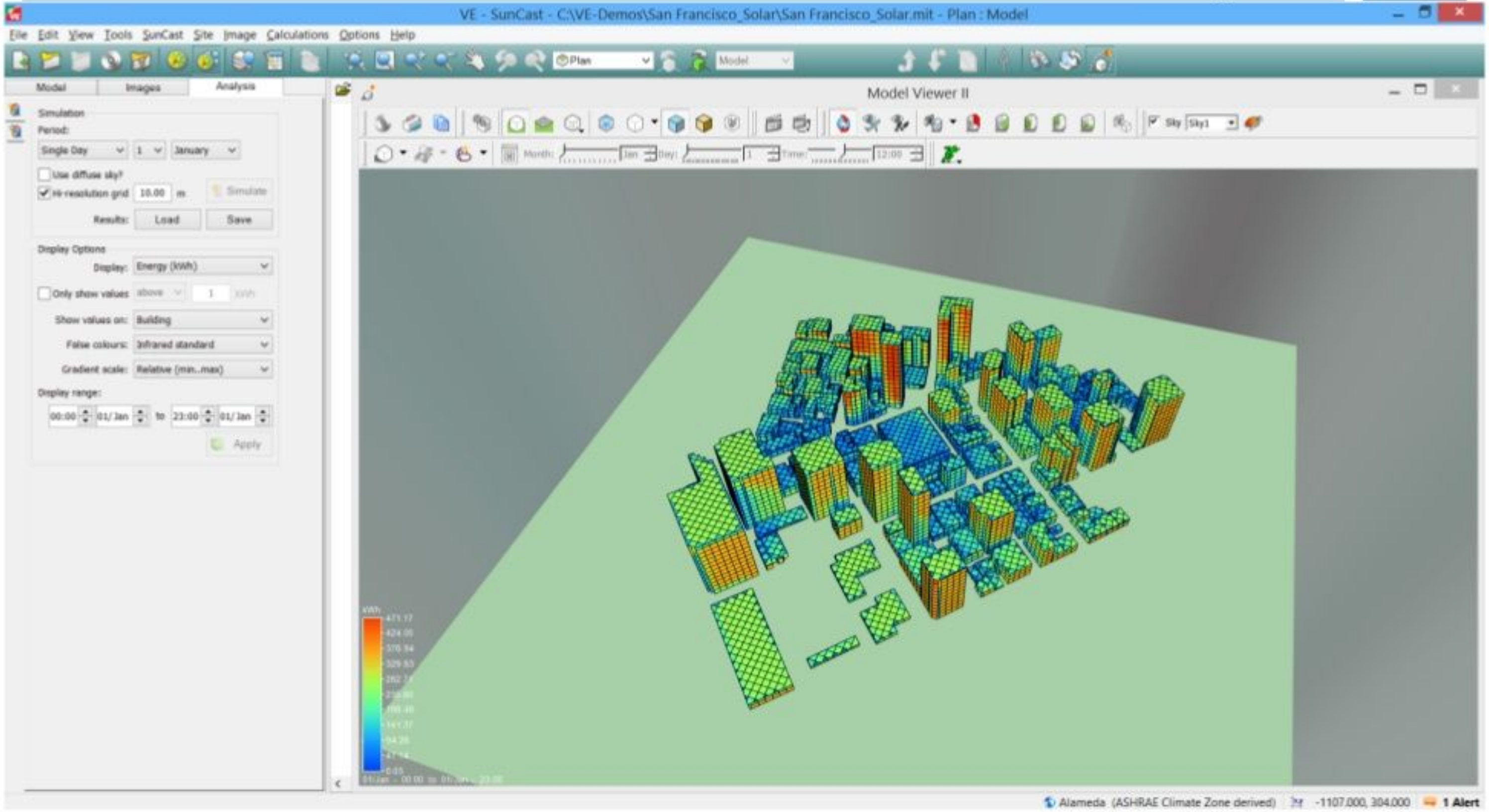
Shadow studies

Tracking Internal Solar Radiation



Surface Solar Radiation: Winter Day

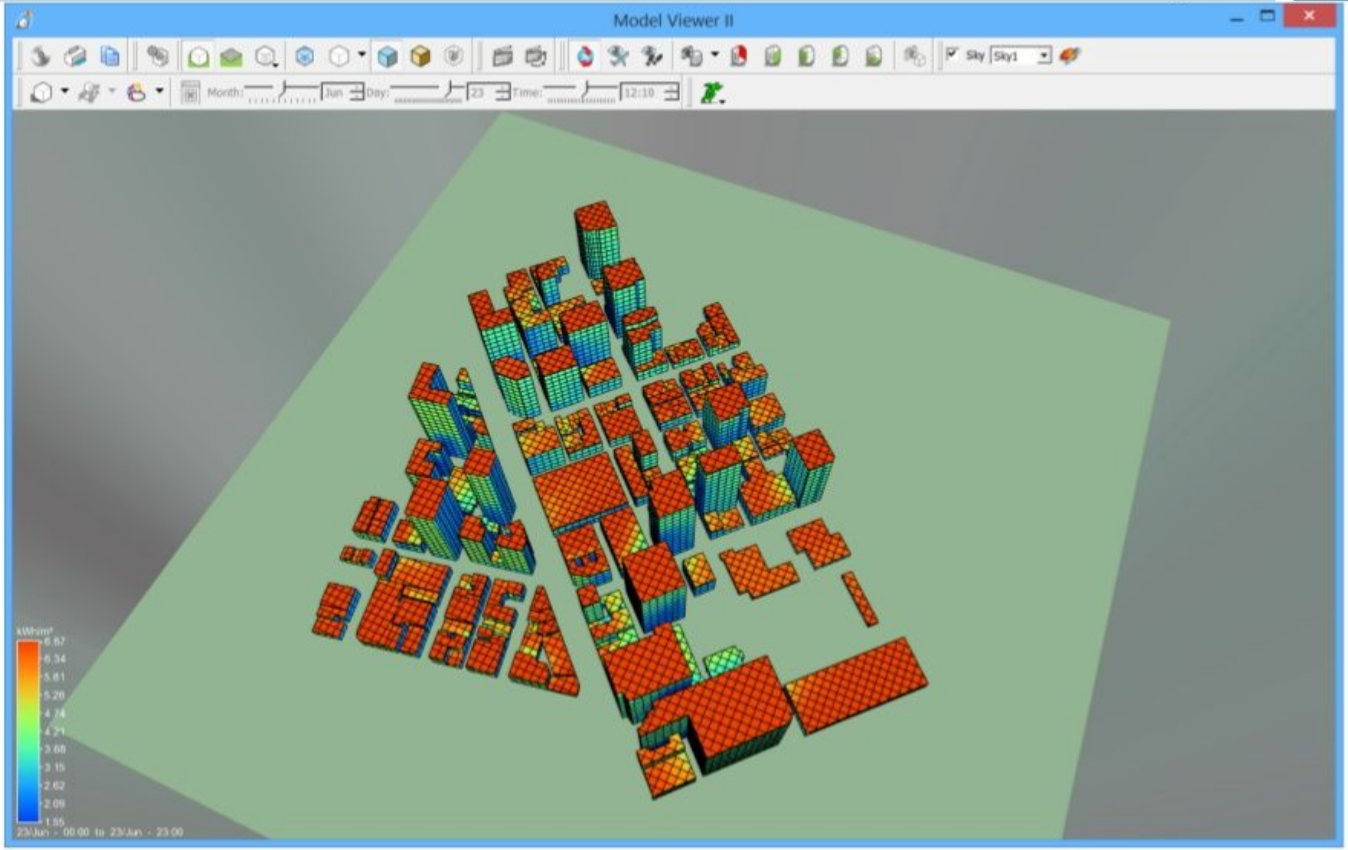
IES



Surface Solar Radiation: 15 January (Red High, Blue Low)

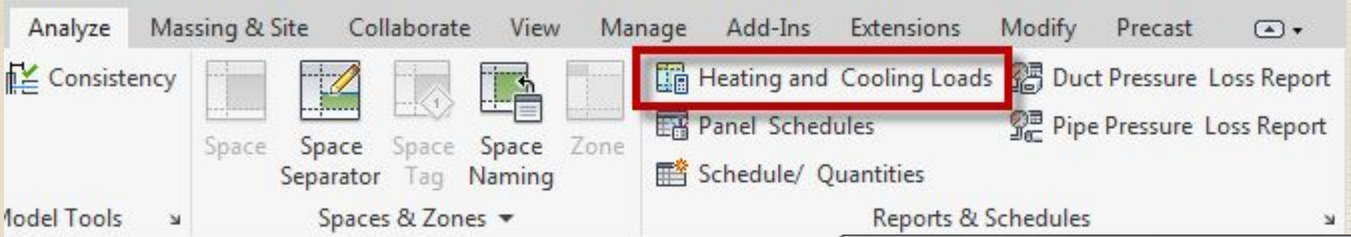
Surface Solar Radiation: Summer Day

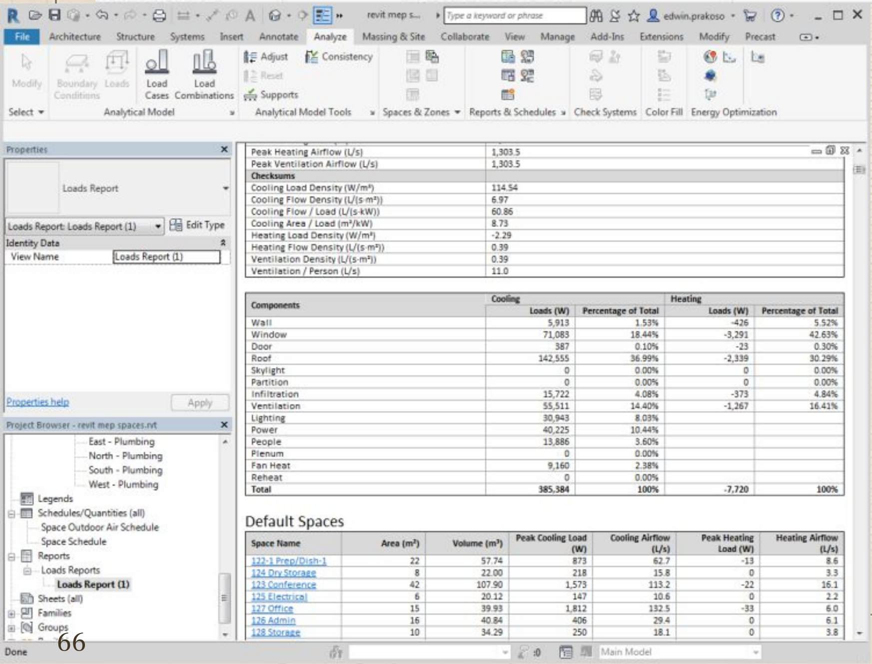
IES

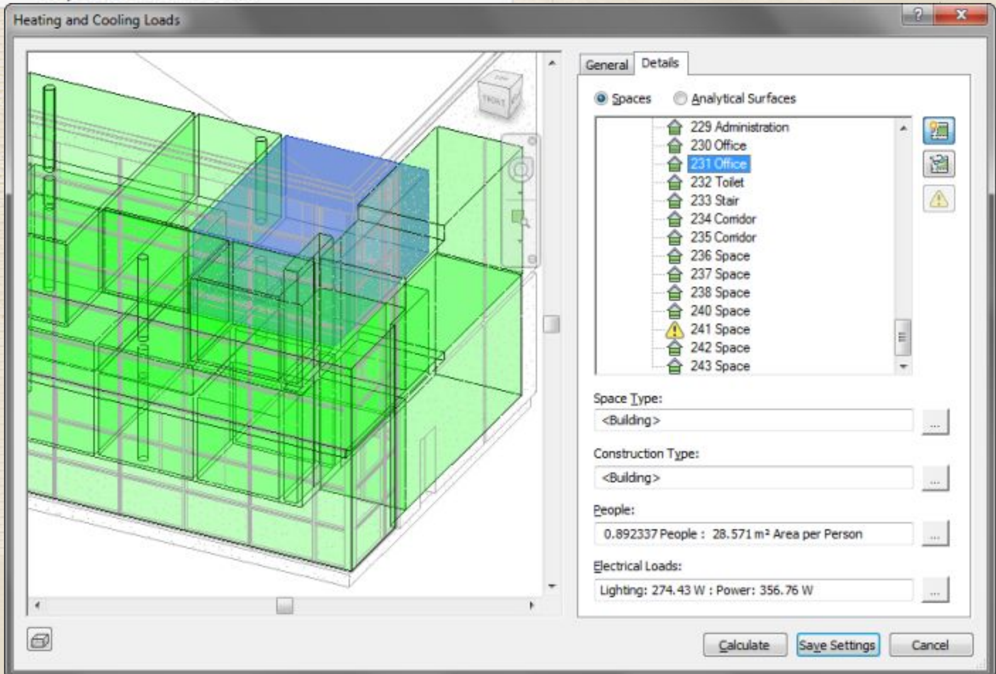


Surface Solar Radiation: 23 June (Red High, Blue Low)

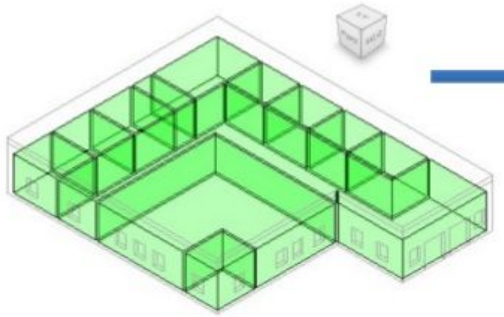
Heating and Cooling Load Calculation







4. Heating and Cooling Load Calculations



Heating and Cooling Loads

Parameter	Value
Building Type	Office
Location	Jeddah Saudi Arabia
Building Service	Constant Volume - Varia
Building Construction	<Building>
Building Infiltration Class	None
Report Type	Standard
Ground Plane	Level 1
Project Phase	New Construction
Sliver Space Tolerance	304.8
Use Load Credits	☐

Building Summary

Inputs	
Building Type	Office
Area (m^2)	158
Volume (m^3)	489.64
Calculated Results	
Peak Cooling Total Load (W)	**18,604**
Peak Cooling Month and Hour	July 2:00 PM
Peak Cooling Sensible Load (W)	17,194
Peak Cooling Latent Load (W)	1,411
Maximum Cooling Capacity (W)	18,604
Peak Cooling Airflow (L/s)	1,325.6
Peak Heating Load (W)	**2,390**
Peak Heating Airflow (L/s)	159.9
Checksums	
Cooling Load Density (W/m^2)	117.79
Cooling Flow Density ($L/(s·m^2)$)	8.39
Cooling Flow / Load (L/(s·kW))	71.25
Cooling Area / Load (m^2/kW)	8.49
Heating Load Density (W/m^2)	15.13
Heating Flow Density ($L/(s·m^2)$)	1.01

Spaces

Space Name	Area (m^2)	Volume (m^3)	Peak Cooling Load (W)	Cooling Airflow (L/s)	Peak Heating Load (W)	Heating Airflow (L/s)
1 Common	56	174.15	3,544	259.5	703	47.0
2 Office 1	7	20.92	1,014	74.3	157	10.5
3 Office 2	7	23.25	960	70.3	121	8.1
4 Office 3	7	22.48	930	68.1	117	7.8
5 Office 4	8	23.81	982	71.9	124	8.3
7 Office 7	7	22.61	1,055	77.2	165	11.0
8 Office 6	8	24.27	1,007	73.7	119	8.0
9 Washroom	6	19.78	721	52.8	96	6.4
10 Office 5	13	41.35	1,792	131.2	248	16.6
11 Department Manager	4	12.37	471	34.5	115	7.7
12 Department	34	104.64	5,623	411.8	425	28.5

Weather Data

Design Conditions

– ASHRAE Handbook of Fundamentals

• Weather Statistics & Observations

– National Climactic Data Center (U.S.)

– Mesowest (Southwest U.S.)

– Weather Bank (International)

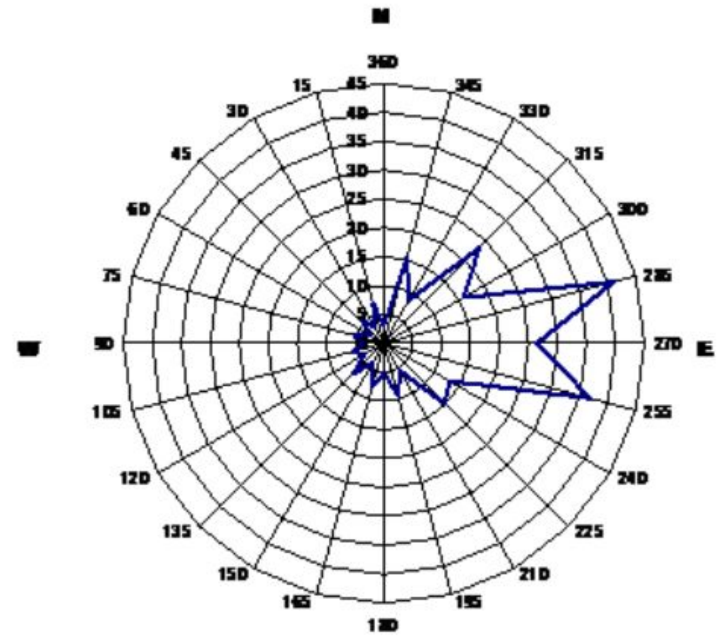
• Annual Weather Data

– DOE-2 Website (TMY, WYEC, etc)

– EnergyPlus Website (EPW, CSV)

• International Weather Data

– EnergyPlus Weather Source Data

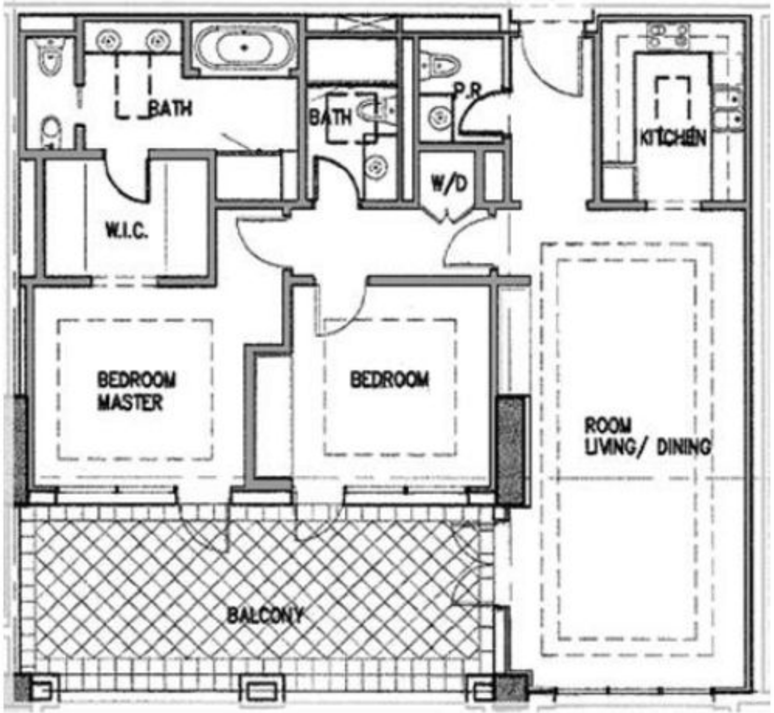


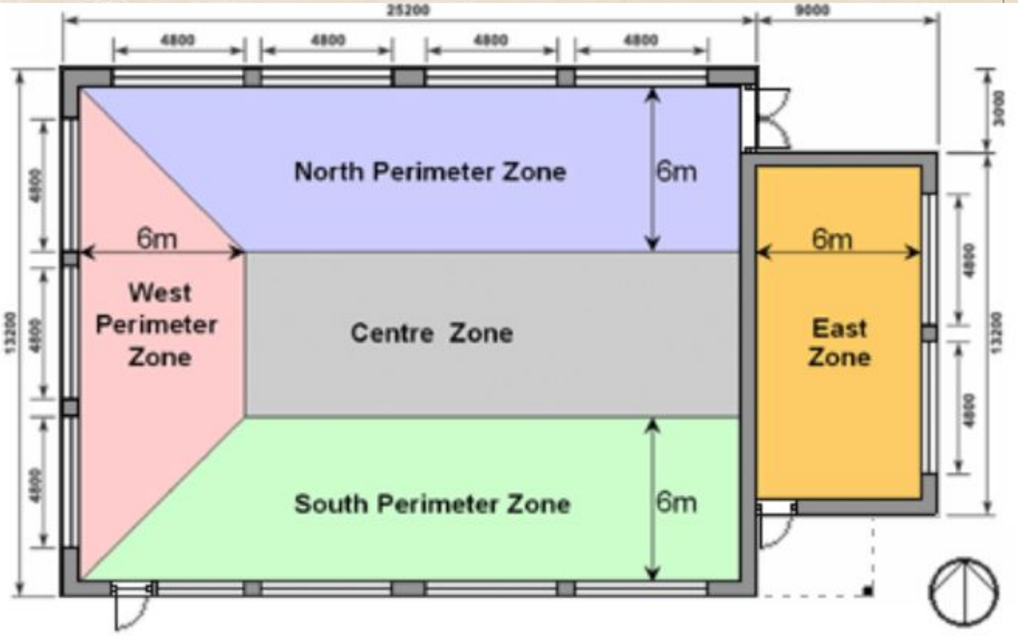
Weather Data

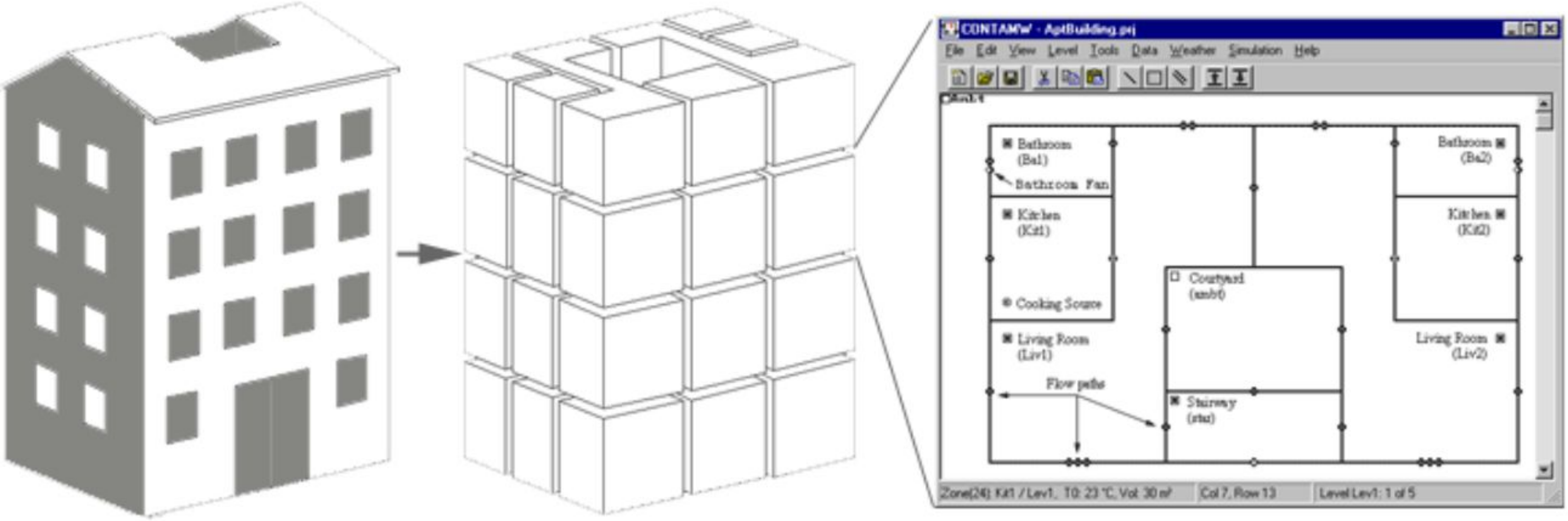
A weather data layer for Google Earth on the US EERE weather file site shows EnergyPlus weather file locations. This allows a designer to compare nearby weather files for the best site match, accounting for any change in elevation, proximity to mountains or water bodies, as shown in Case Study 5.3. Google Earth images use data from SIO, NOAA, the U.S. Navy, NGA, GEBCO, Cnes SpotImage, Terrametrics, and IBCAO



Thermal Zoning






CONTAMW - AptBuilding.prj
File Edit View Level Tools Data Weather Simulation Help
Bathroom (Ba1)
Bathroom Fan
Kitchen (Kit1)
Cooking Source
Living Room (Liv1)
Flow paths
Courtyard (ambt)
Stairway (stai)
Bathroom (Ba2)
Kitchen (Kit2)
Living Room (Liv2)
Col 7, Row 13
Level Lev1: 1 of 5

Criteria For Zoning An Energy Model Usage

• All rooms should have similar internal loads and usage schedules Temperature Control

• All rooms should have the same Tstat schedules Solar Gains

• Perimeter zones with windows: Min. one zone for each compass direction

• Unglazed exterior zones can be combined

• Consider shading!

Perimeter or Interior Location

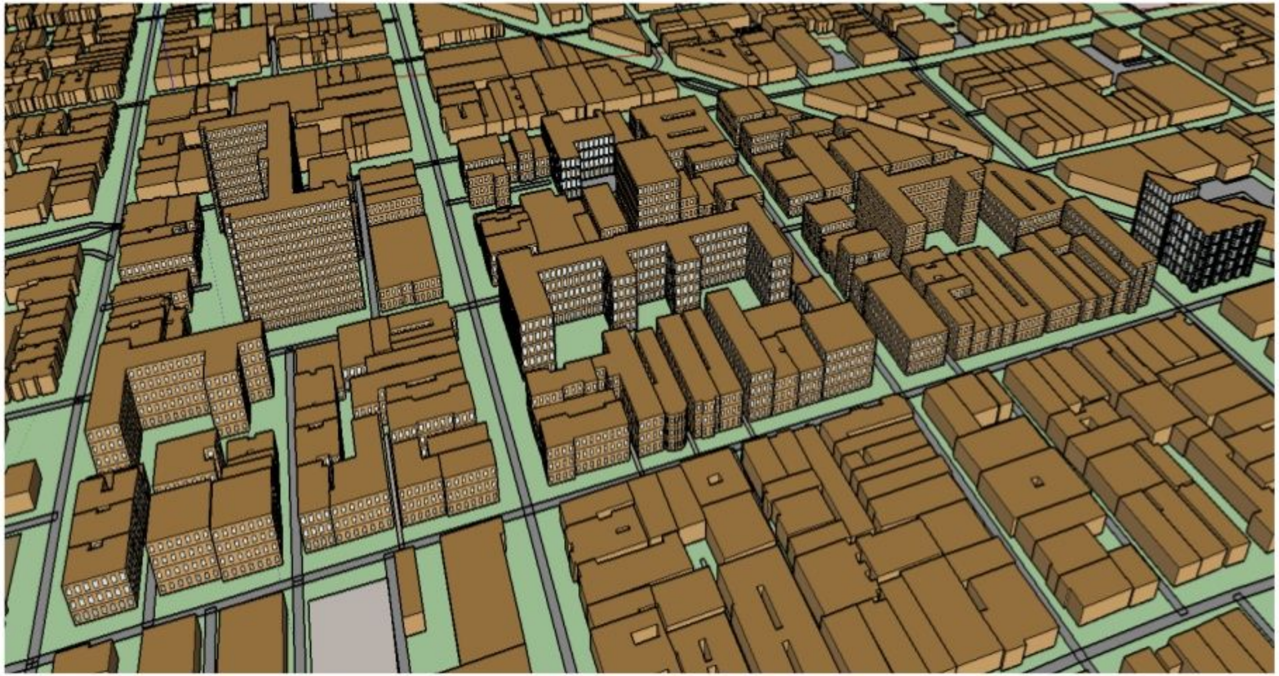
• 12-15’ perimeter zones often require winter heating

• Core spaces can require year round cooling Distribution System Type

•Combine rooms served by the same type of distribution system (i.e.
fan coil units)

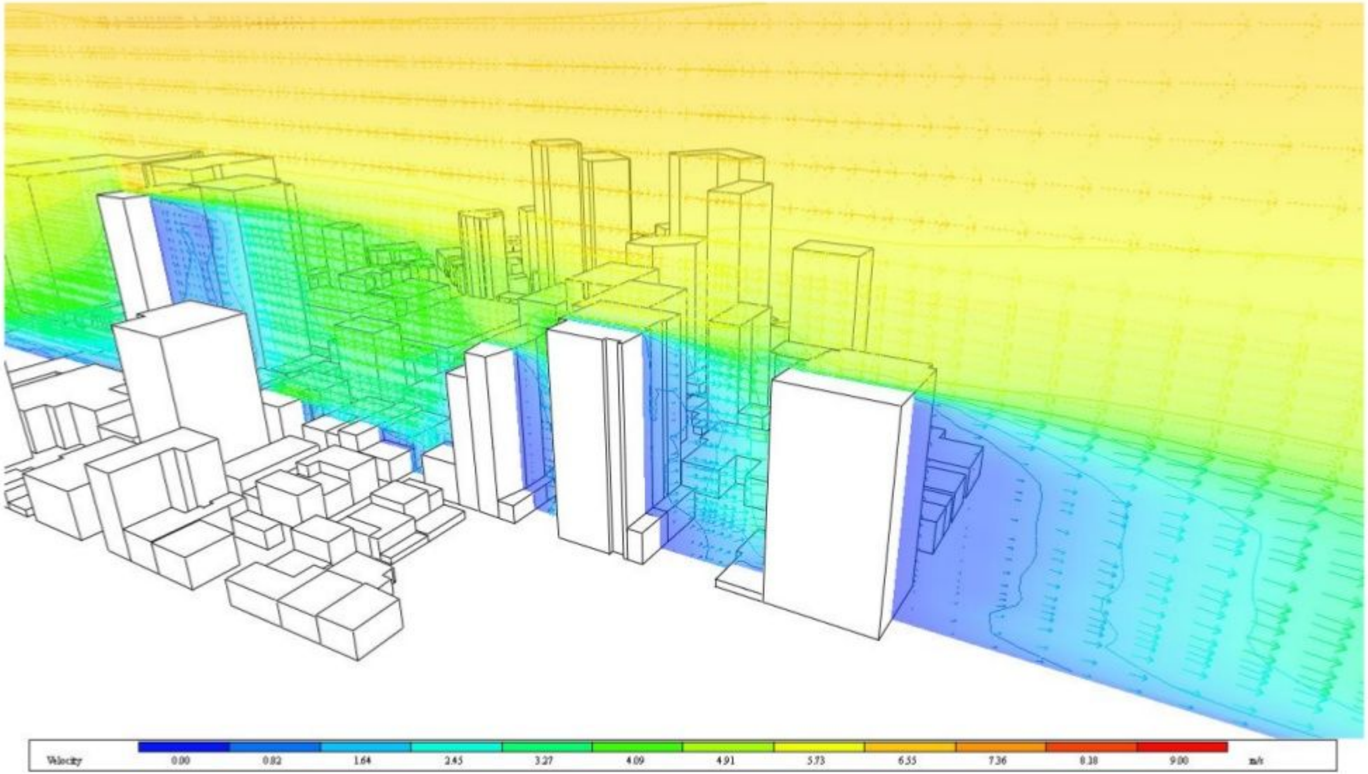
Energy Analysis

IES

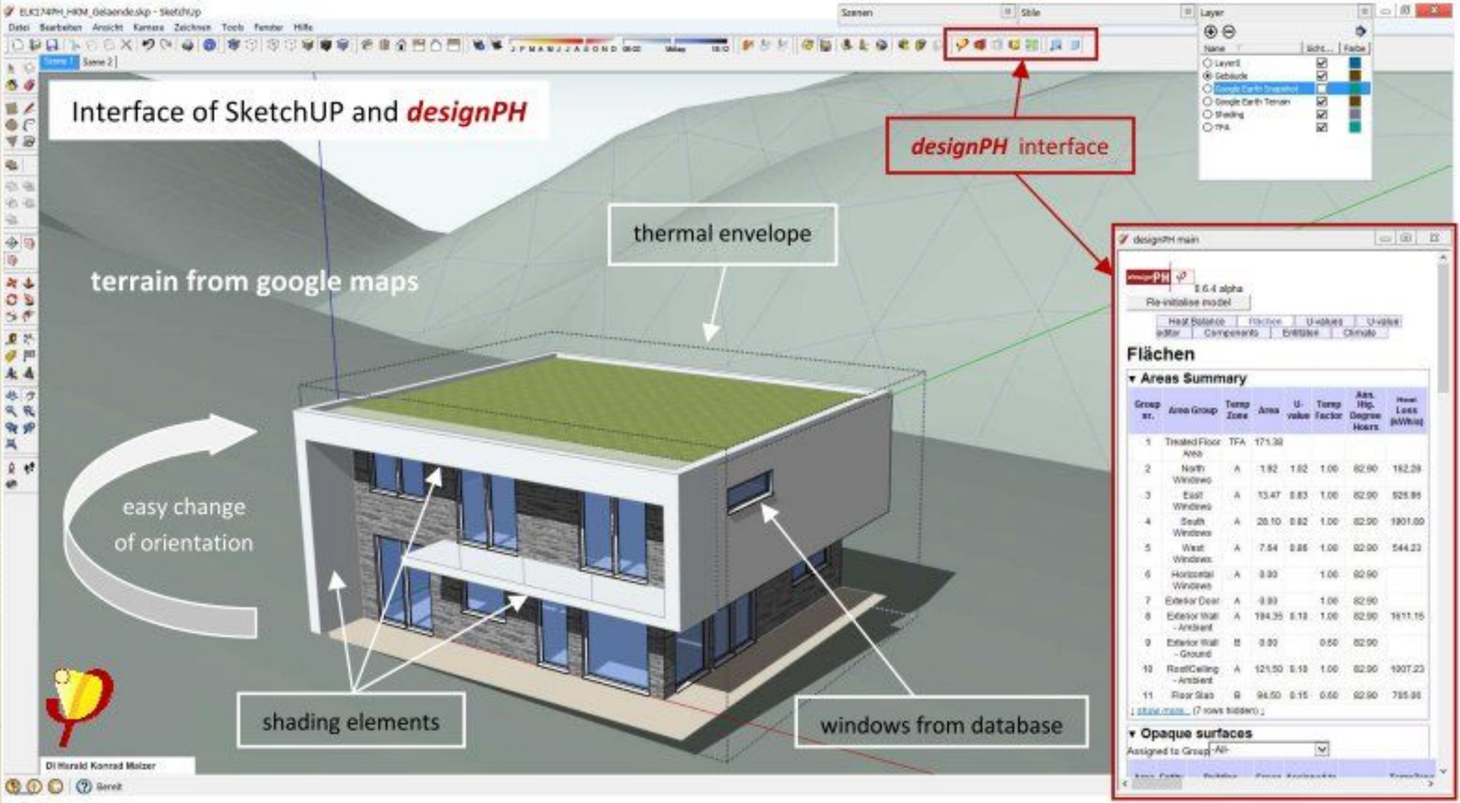


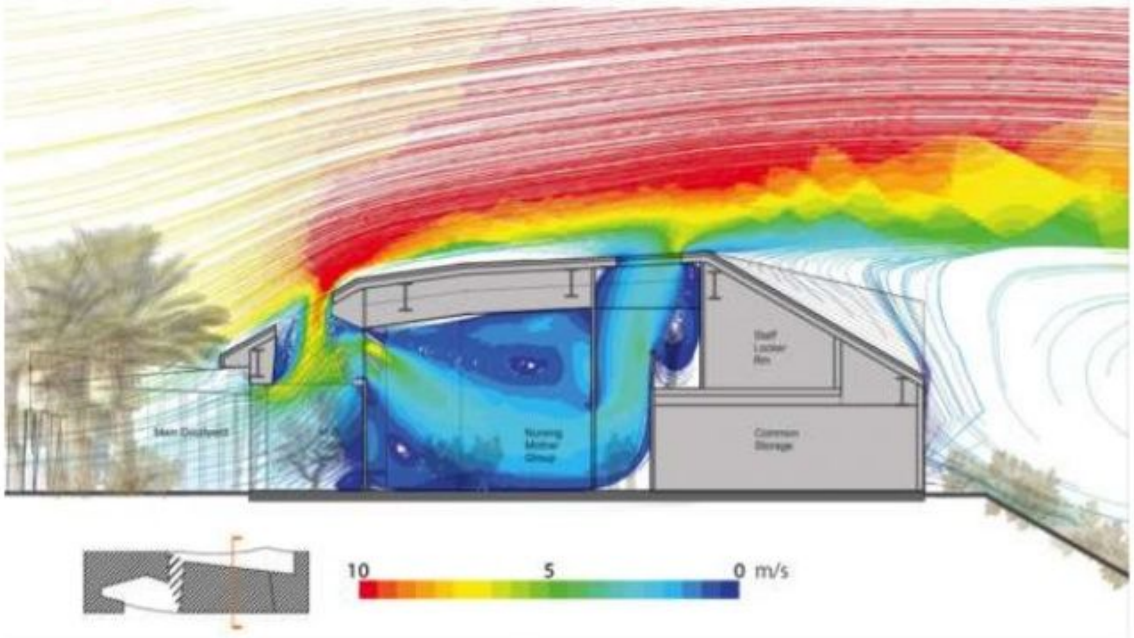
District buildings modelled in more detail

VE-Pro: External Air Flow

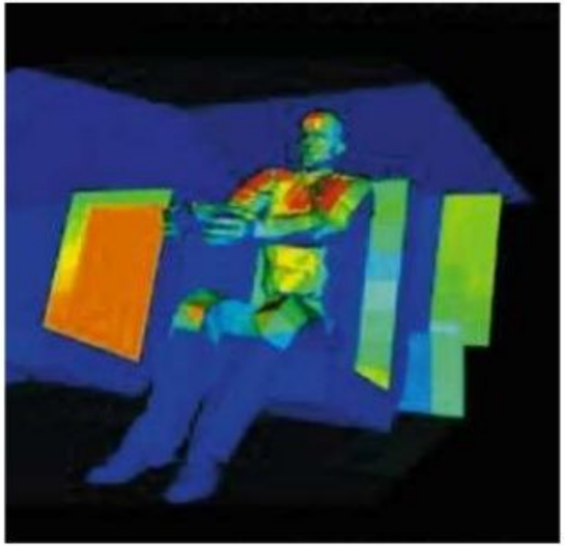


Passive Design

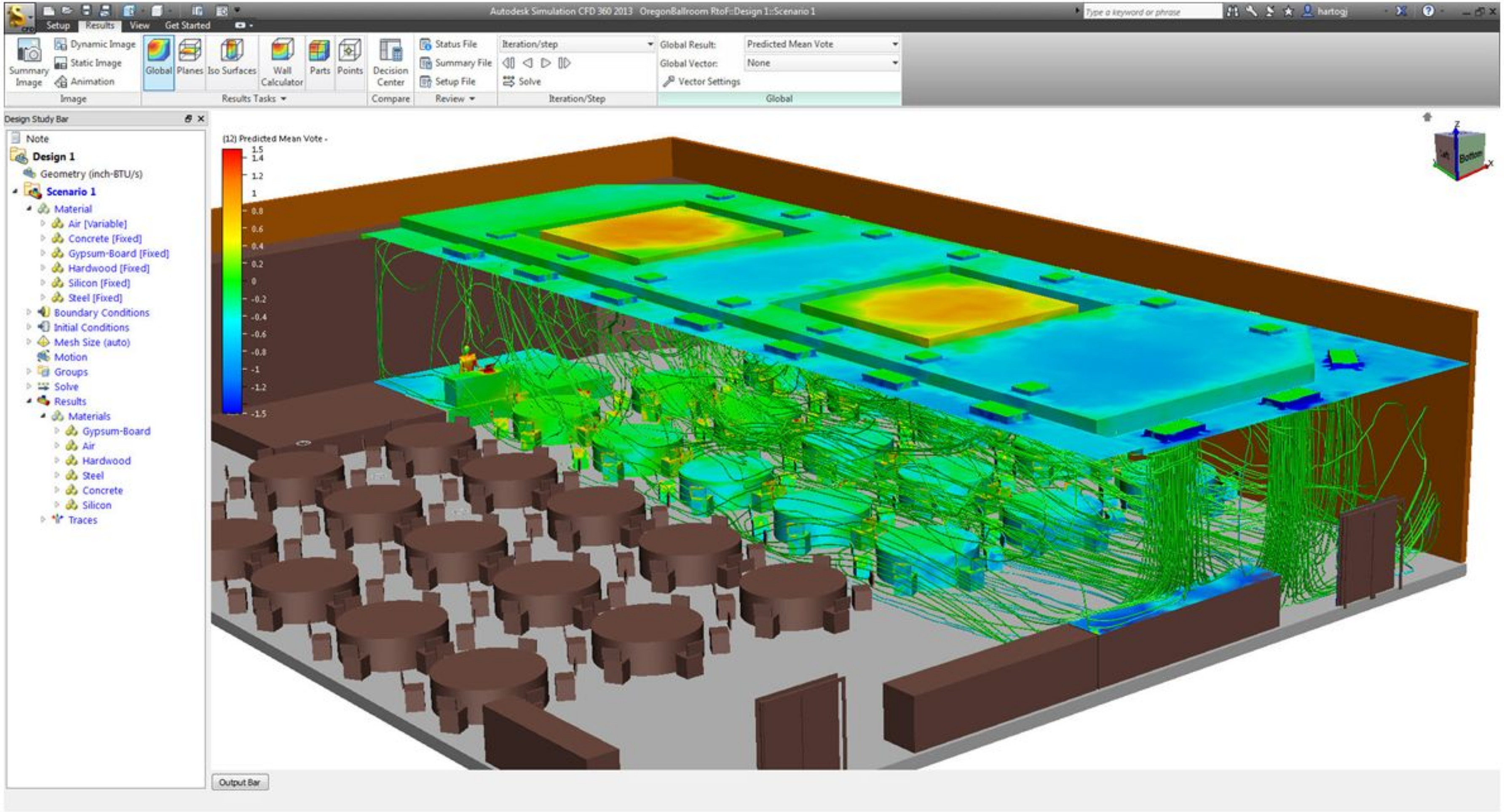




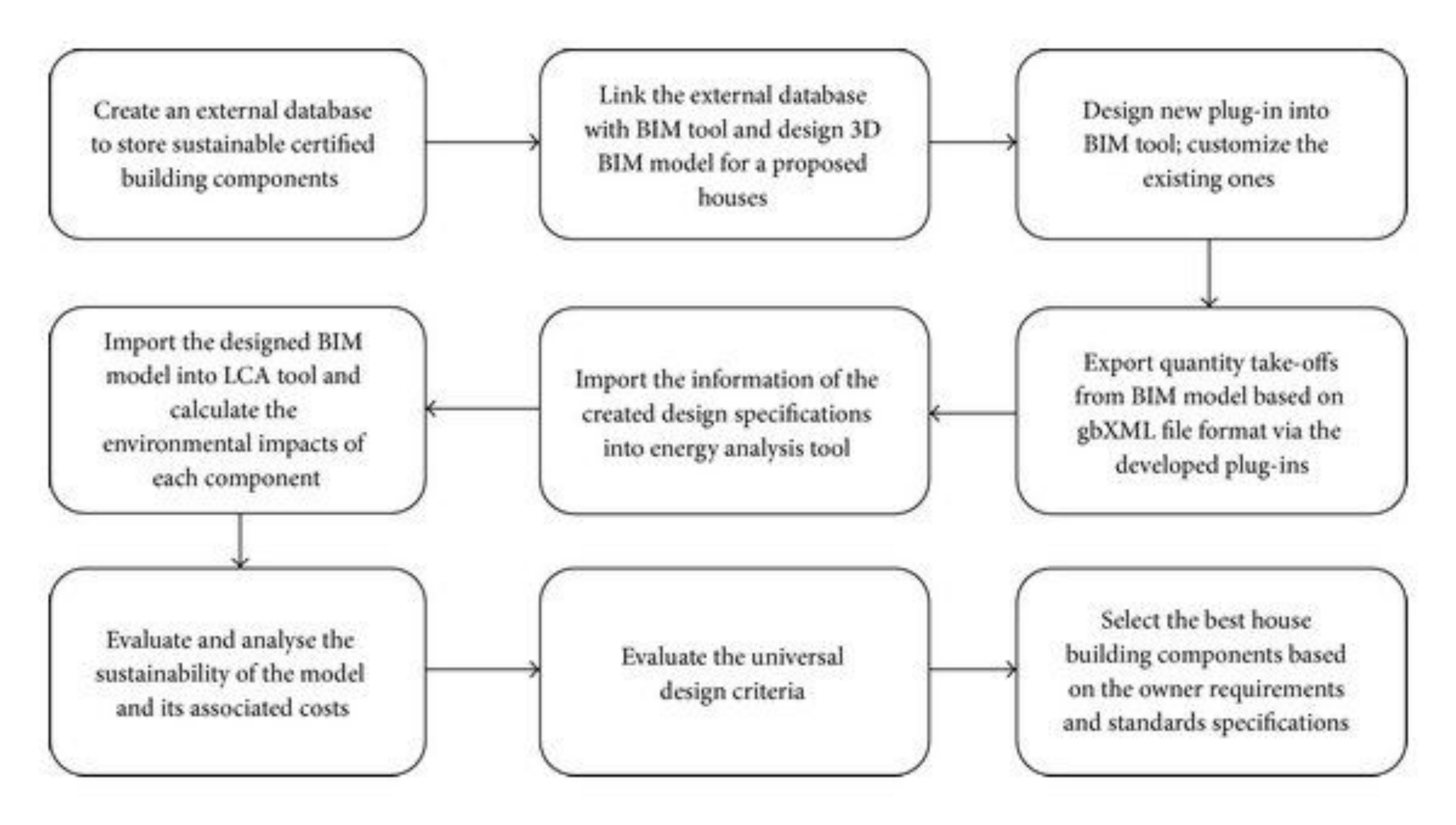
Building Form Optimization for Natural Ventilation with Using CFD simulation, ISOENV with MODU Architecture NY, 2014



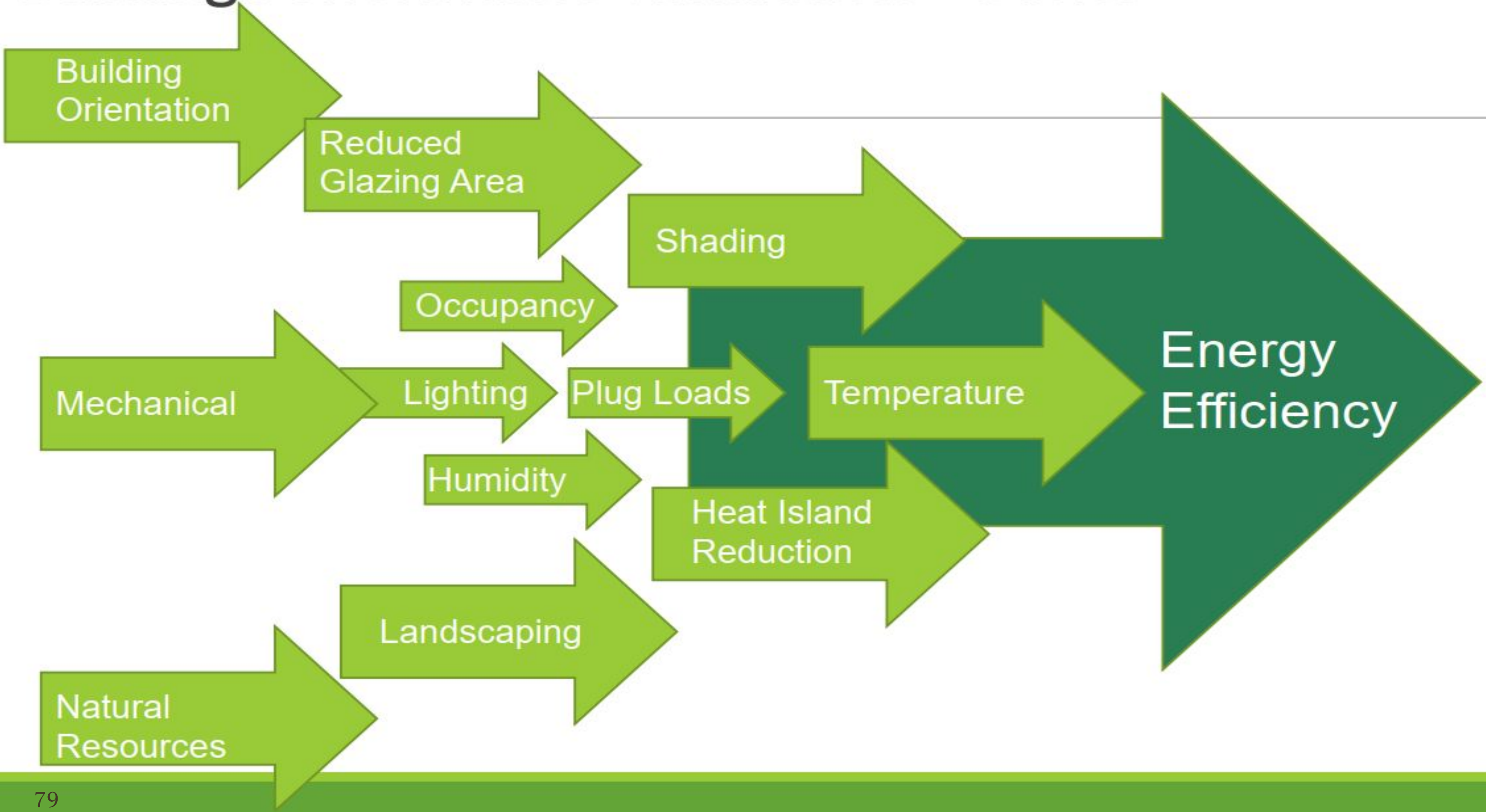
Automation simulation


Autodesk Simulation CFD 360 2013 OregonBallroom RtoF::Design 1::Scenario 1
Setup
Results
View
Get Started
Summary Image
Dynamic Image
Static Image
Animation
Image
Global
Planes
Iso Surfaces
Wall Calculator
Parts
Points
Results Tasks
Decision Center
Compare
Status File
Summary File
Setup File
Review
Iteration/step
Solve
Iteration/Step
Global Result:
Predicted Mean Vote
Global Vector:
None
Vector Settings
Global
Design Study Bar
Note
Design 1
Geometry (inch-BTU/s)
Scenario 1
Material
Air [Variable]
Concrete [Fixed]
Gypsum-Board [Fixed]
Hardwood [Fixed]
Silicon [Fixed]
Steel [Fixed]
Boundary Conditions
Initial Conditions
Mesh Size (auto)
Motion
Groups
Solve
Results
Materials
Gypsum-Board
Air
Hardwood
Steel
Concrete
Silicon
Traces
(12) Predicted Mean Vote -
1.5
1.4
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.5
Output Bar

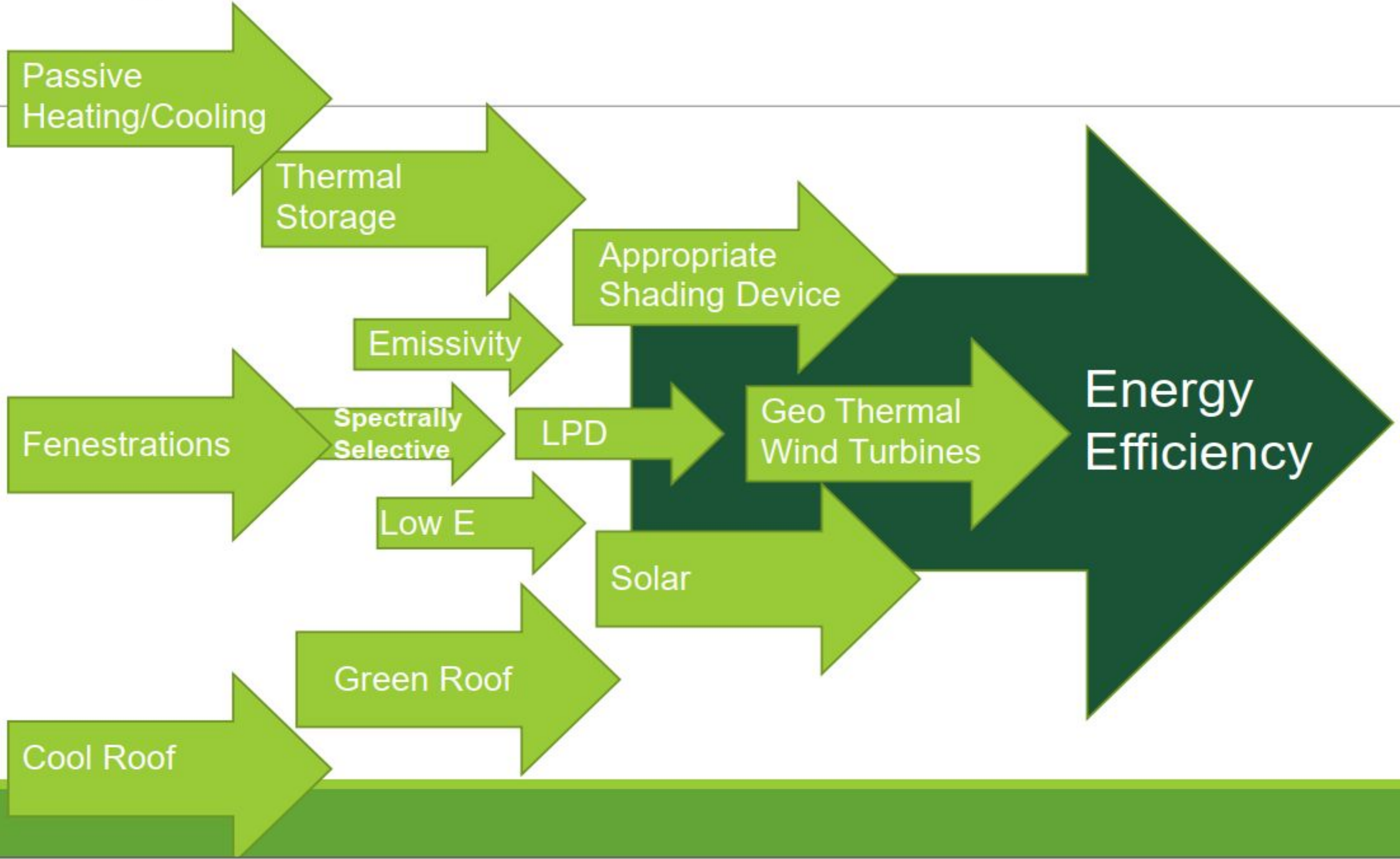
Methodology of the integration system



Building Performance Simulation – Basics



Building Performance Simulation – Advanced



R&D - INDICATE

IES



www.iesve.com UNITED KINGDOM | IRELAND | UNITED STATES OF AMERICA | CANADA | INDIA | AUSTRALIA



SOFTWARE

SOFTWARE

"Software doesn't design sustainable buildings, people do." – Elrond Burrell

List of approved LEED software

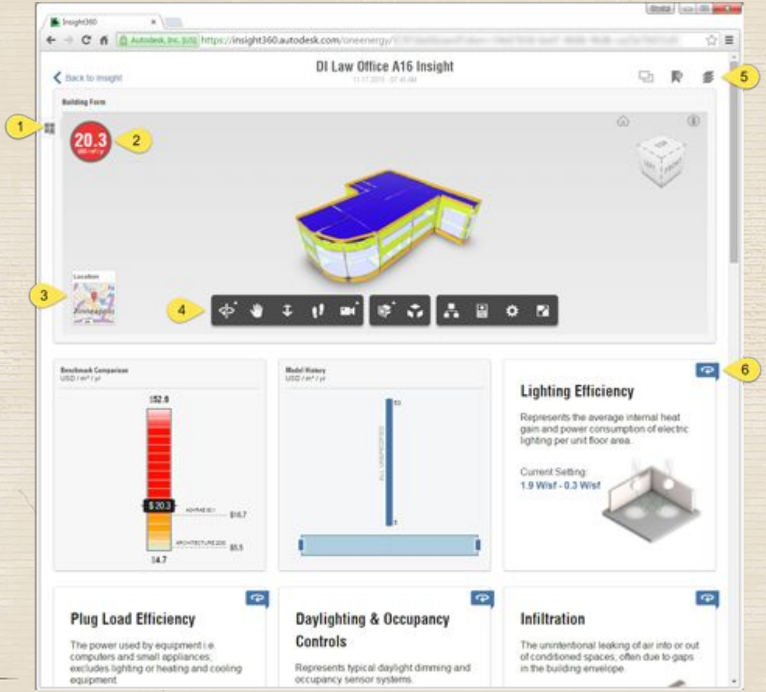
- DOE2
- eQUEST
- Visual DOE
- EnergyPlus
- EnergyPro
- HAP (Carrier HAP)
- TRACE 700 (Trane TRACE)
- BLAST (not mentioned within the LEED form, but listed in 90.1 section G2)
- IES (Integrated environmental solutions, listed in LEED Advanced energy modeling .

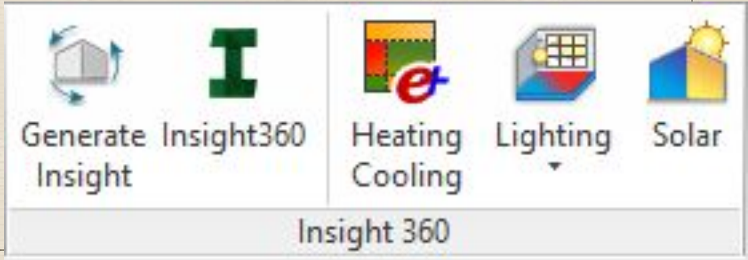
Energy simulation programs

approved by Canada Green Building

- Council (CaGBC):
- eQuest
- EE4
- DOE-2
- EnergyPlus
- IES Virtual Environment,
- Hourly Analysis Program (HAP)
- TRACE 700
- EnergyPro v5.1.

- Insight 360 (new tool just announced by Autodesk at Greenbuild 2015)
- *New cloud-based tool enabling a new way to experience building energy and environmental performance and the collective actions that lead to better outcomes throughout all stages of the building lifecycle.*





Insight 360

- Solar Analysis

Visualize and quantify the distribution of solar radiation on various surfaces.

- Light Analysis

Analysis for illuminance and validation for LEED v3 IEQc8.1 and LEED v4 IEQ Daylight Credit, Option 2.

- Heating and Cooling Loads

Tool used primarily by mechanical engineers to size HVAC equipment.

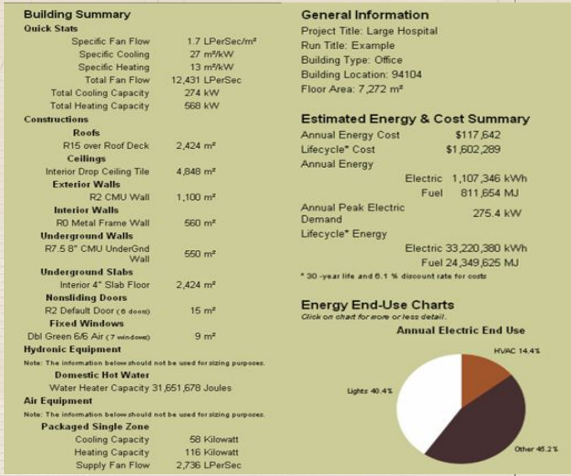
- Generate Insight

Automatically varies building design inputs resulting in high and low possible annual energy costs with approximately +/- 10% accuracy. Inputs can then be adjusted, e.g., glazing properties, to see instant feedback on performance impacts.

Software

External to Revit

- Green Building Studio (GBS)
- *Standalone cloud-based whole building performance analysis using the DOE2 simulation engine.*
- Web-based solution
- Early building energy design decisions
- Whole building energy analysis
- Design alternative comparisons





Software

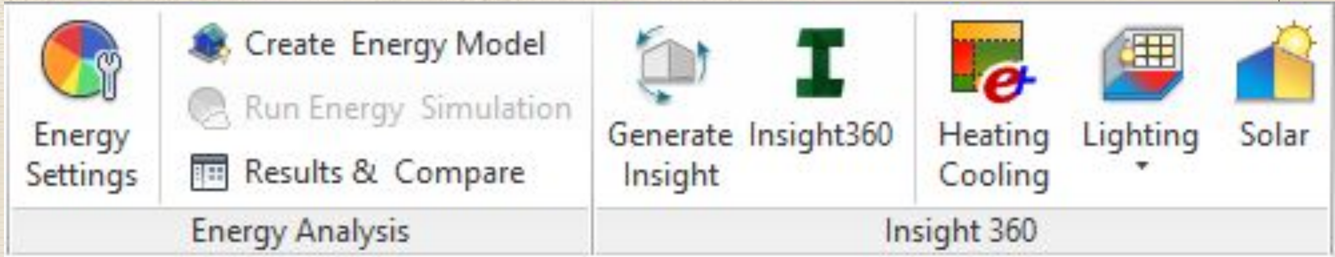
WITHIN REVIT

- ENERGY ANALYSIS

ANALYZE A DESIGN'S EXPECTED ENERGY USE BASED ON GEOMETRY AND LOCATION ON EARTH.

Energy Settings dialog (**Analysis** tab)

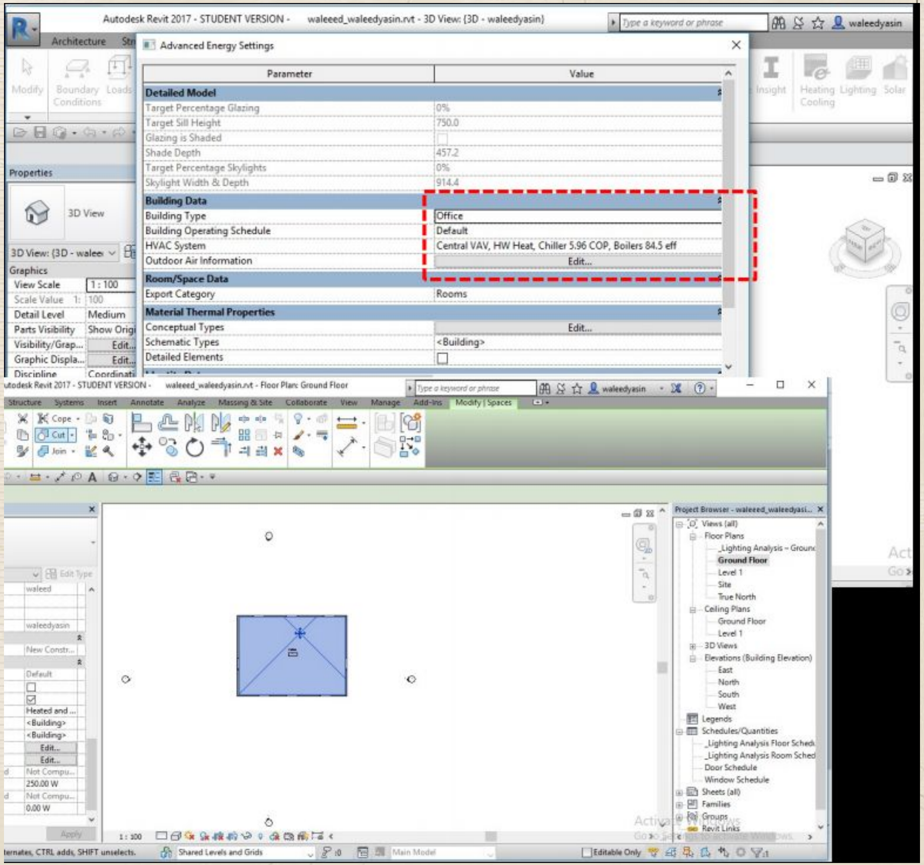
- Set Location
- Select Project Phase
- Specify **Analysis Mode:** Avoid *Use Conceptual Masses* setting)
- All other settings are optional

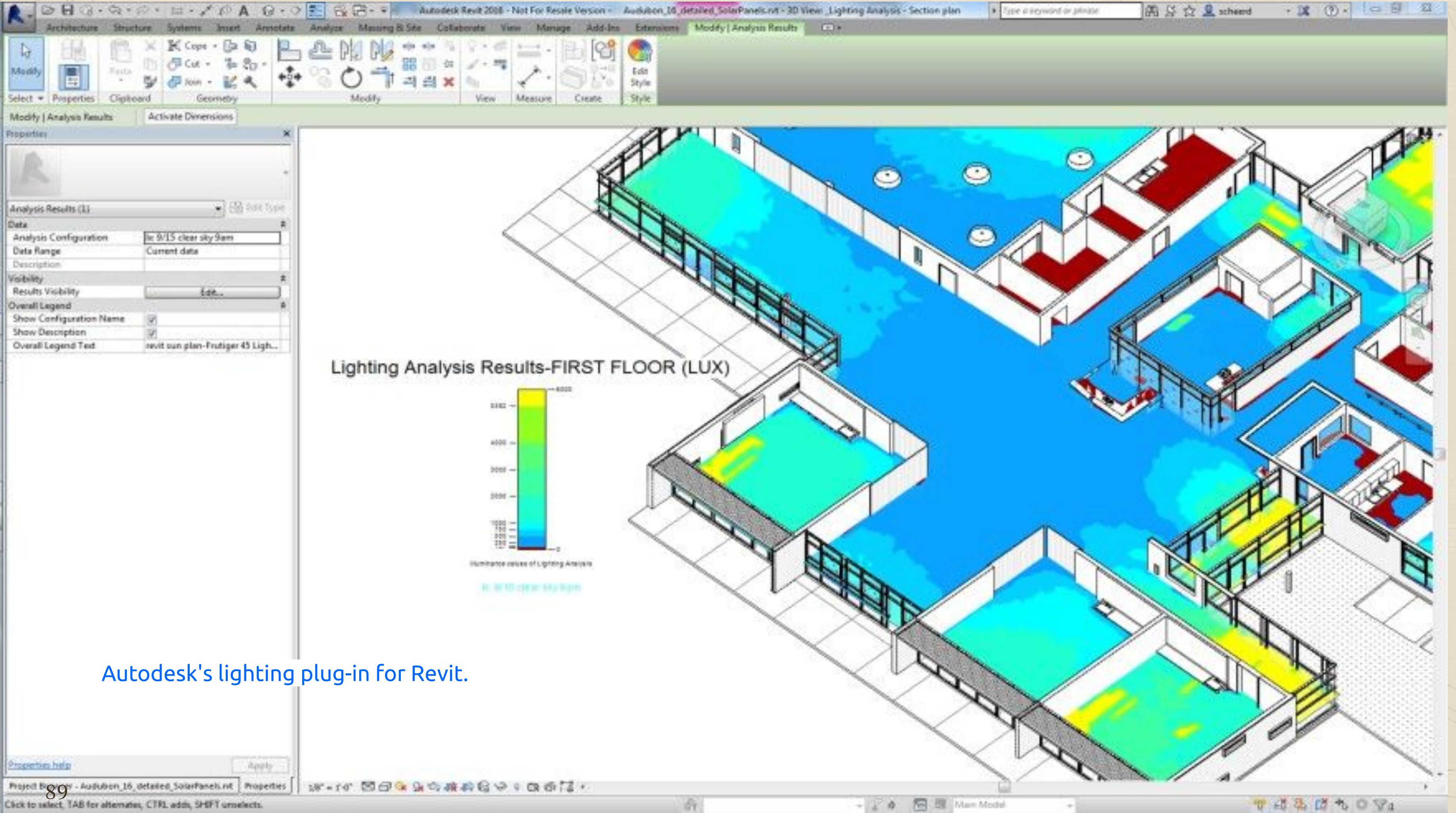


Energy Analysis tools on the Analysis tab in Revit 2016 R2, plus the Insight 360 add-in.

ENERGY CONSUMPTION – HVAC LOAD – THERMAL COMFORT

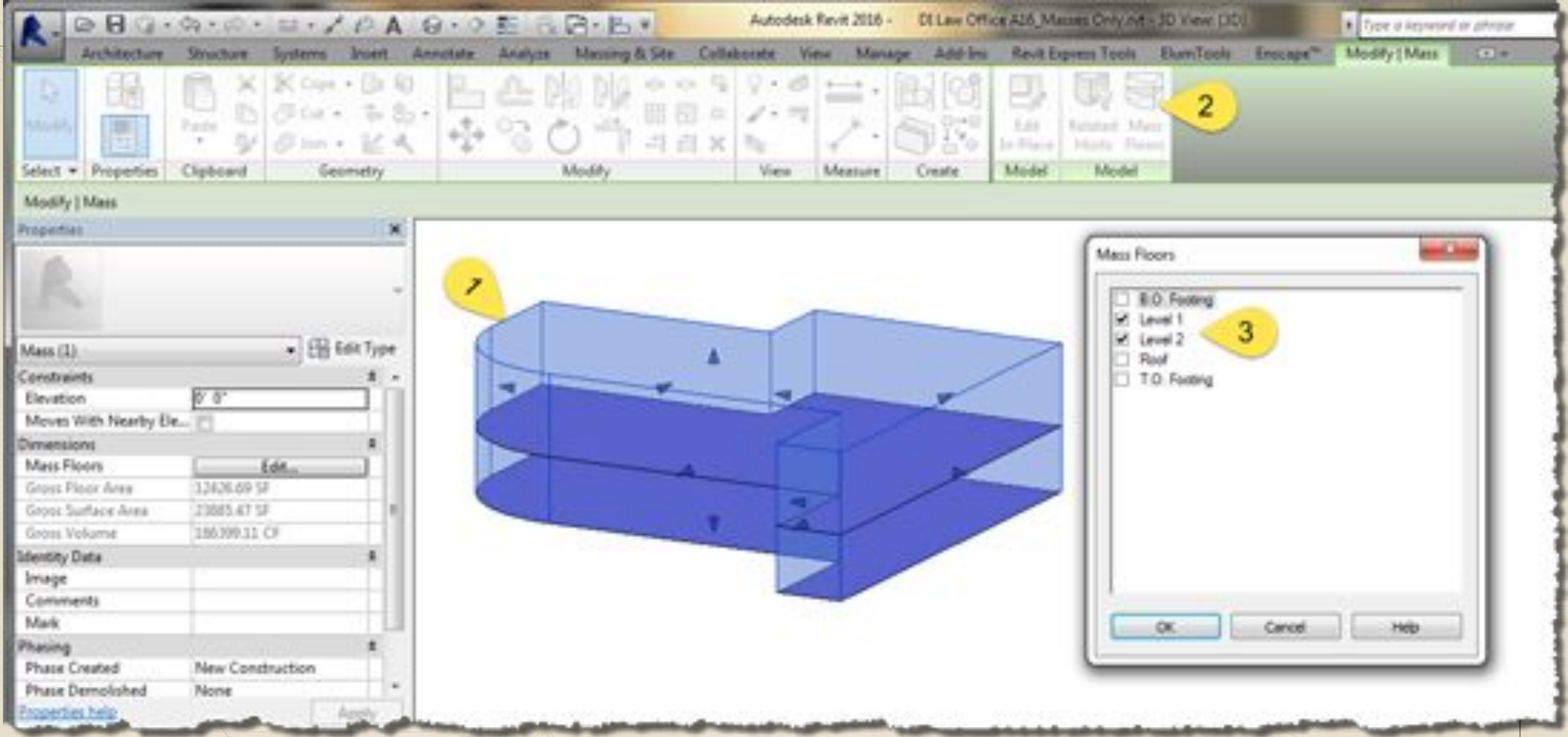
•FUNCTION •OCCUPANCY
•CONSTRUCTION •LIGHTING
•SCHEDULE •HVAC SETPIONT
•DEMOSTIC WATER •MECHANICAL VENTILATION •NATURAL VENTILATION •INFILTRATION •(ACH)



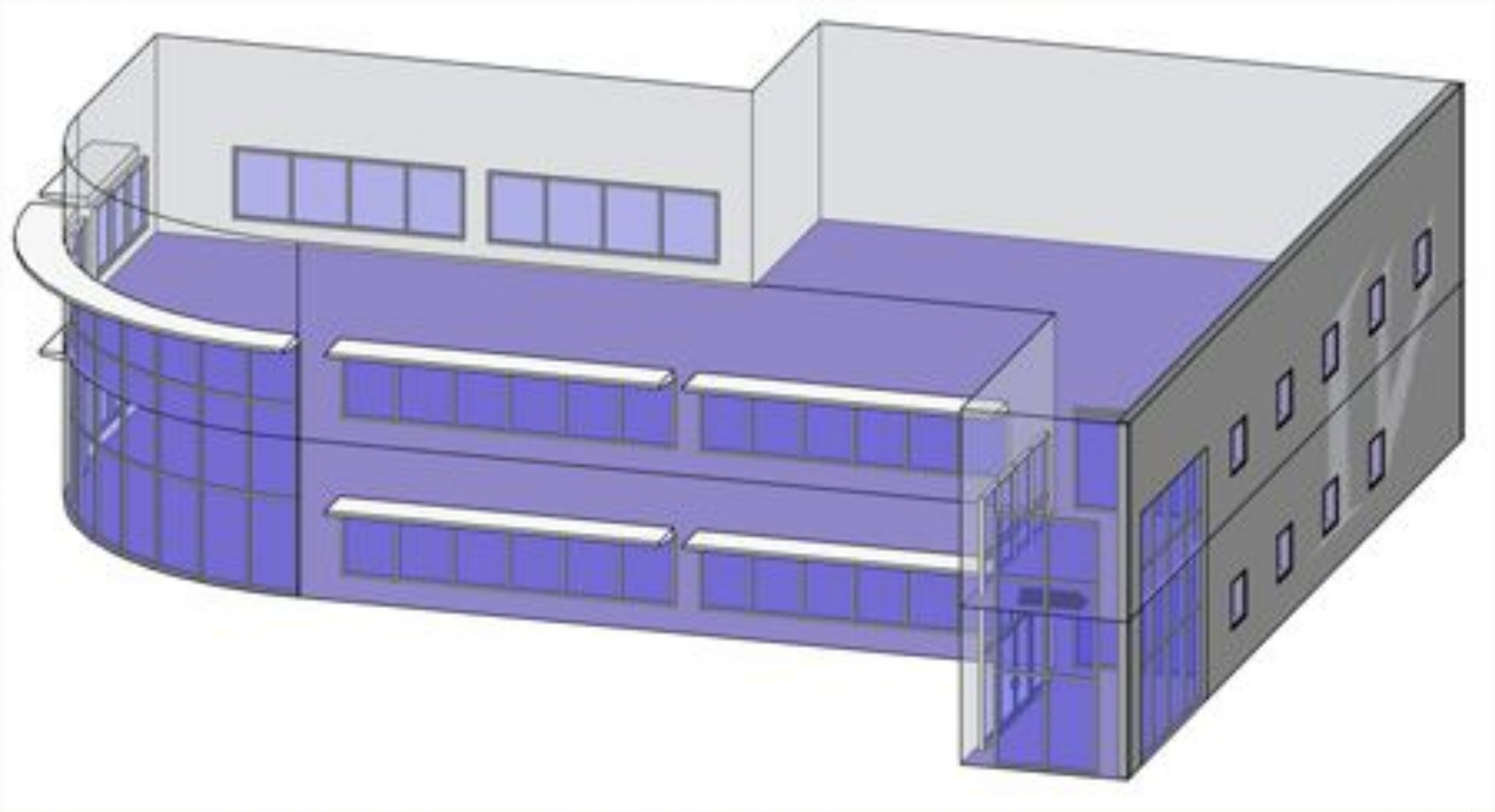


Autodesk's lighting plug-in for Revit.

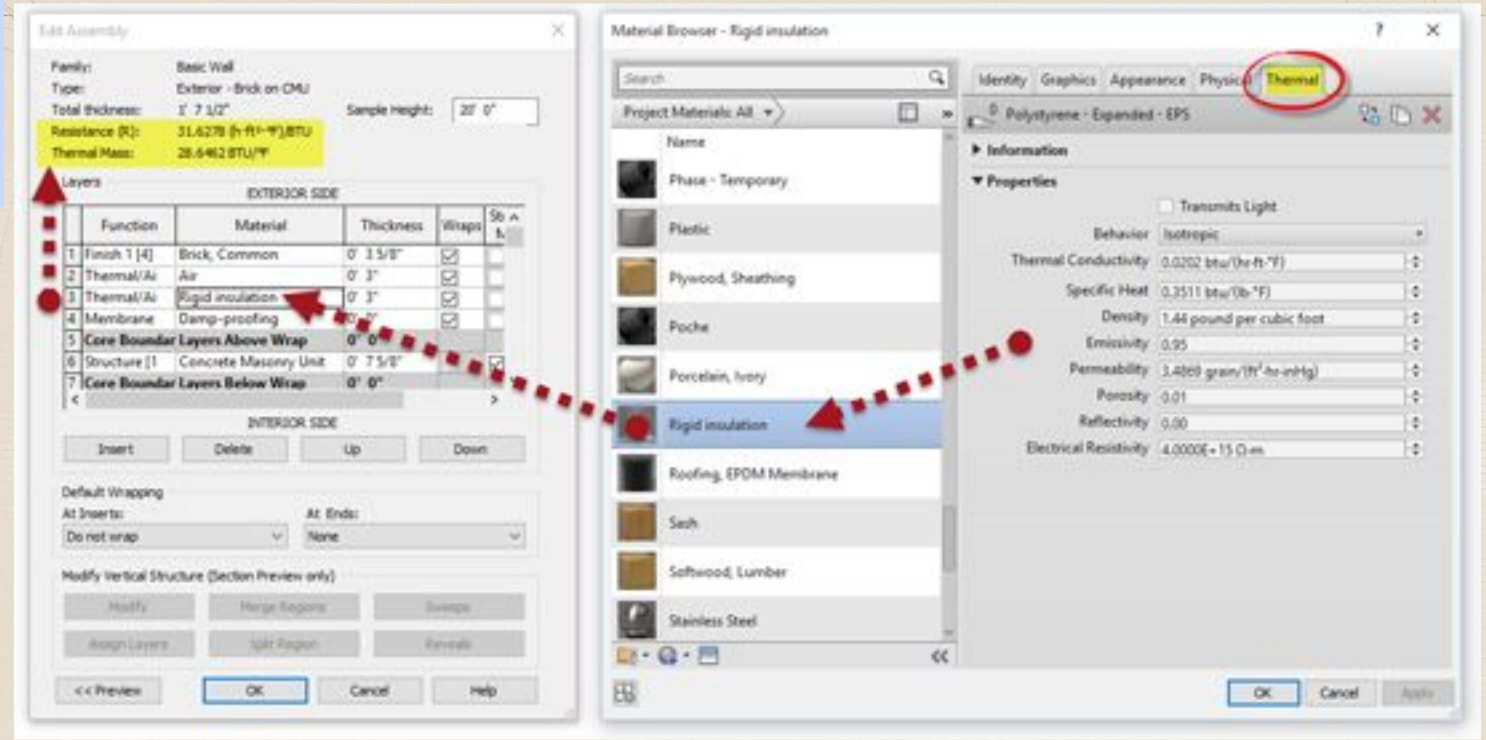
Software



Masses must have 'mass floors' specified to create a valid EAM.

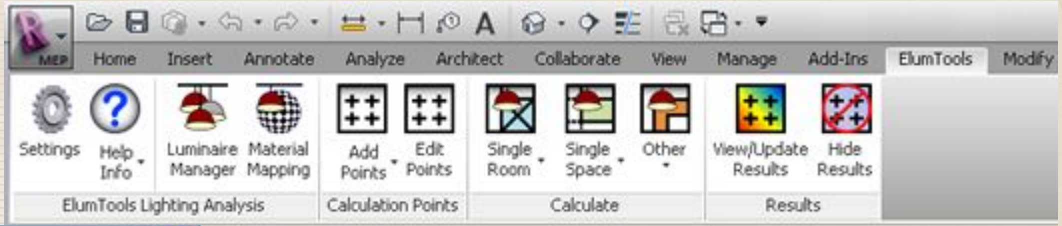


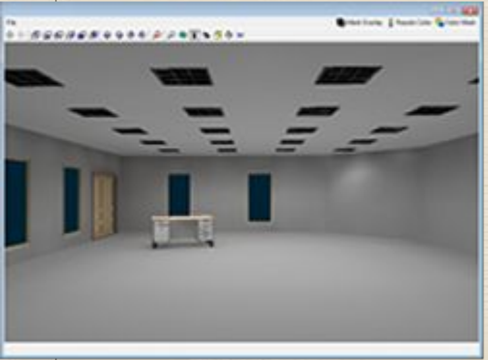
Masses and Building Elements used together in energy analysis.

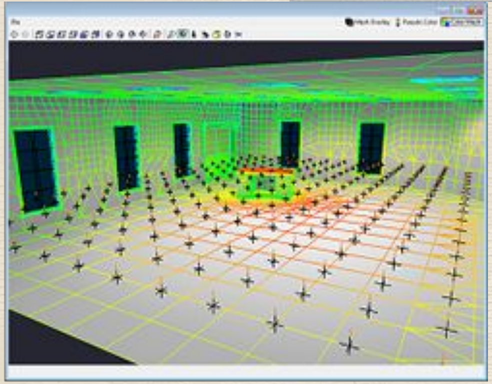


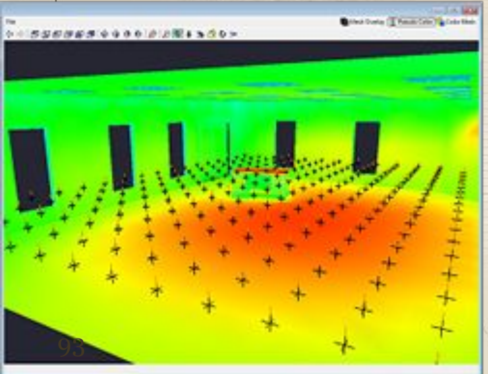
Thermal properties associated with building elements can be used in the energy simulation.

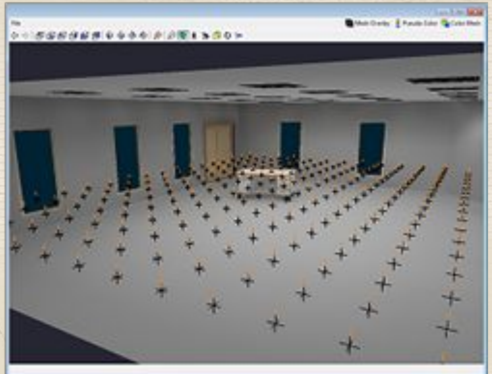
ElumTools

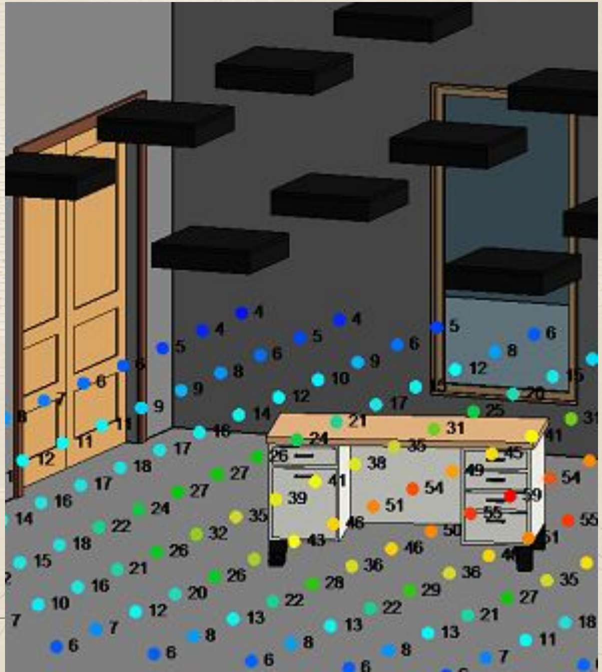

MEP
Home
Insert
Annotate
Analyze
Architect
Collaborate
View
Manage
Add-Ins
ElumTools
Modify
Settings
Help Info
Luminaire Manager
Material Mapping
Add Points
Edit Points
Single Room
Single Space
Other
View/Update Results
Hide Results
ElumTools Lighting Analysis
Calculation Points
Calculate
Results



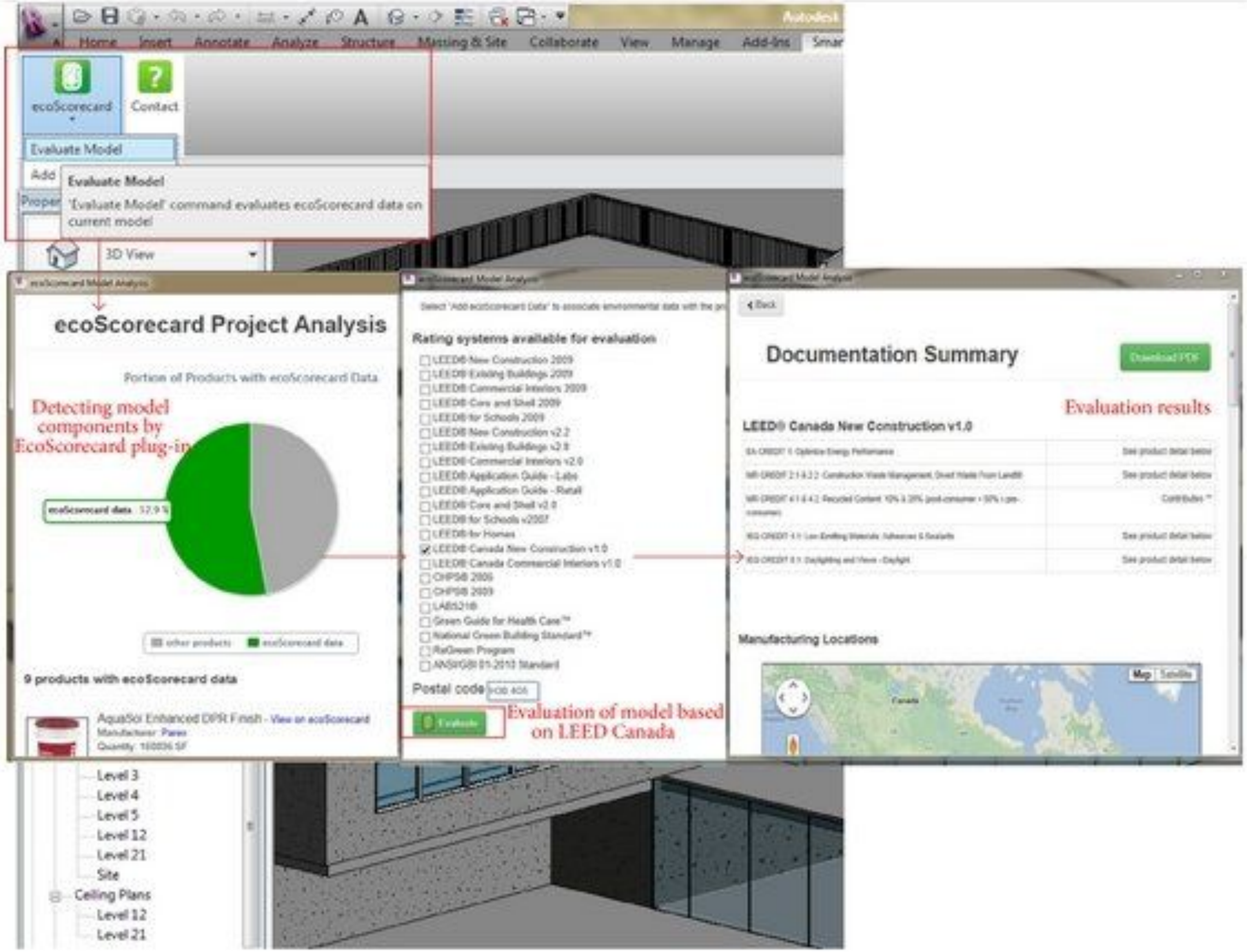








EcoScorecard plug-in



Energy Simulation Plug-ins for Revit

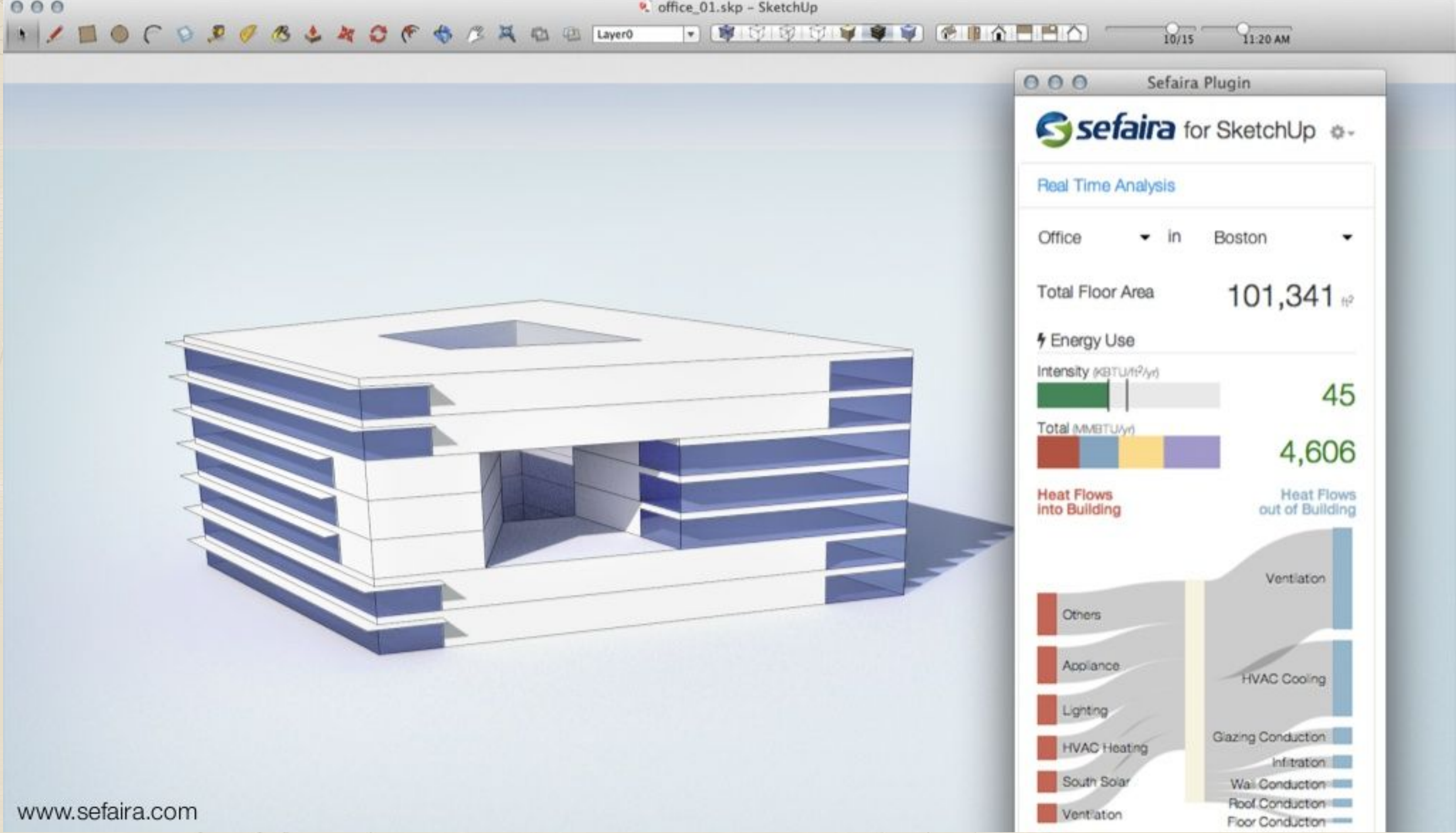
- Energy simulation plug-ins available for Revit:

  IES-VE, Design Builder and Sefaira.

- IES and Design Builder are 2 standalone energy simulation software famous among energy modelers and MEP consultants.

- Sefaira is a new player and started with energy and daylight plug-ins for Sketchup and then launched a Revit plug-in.





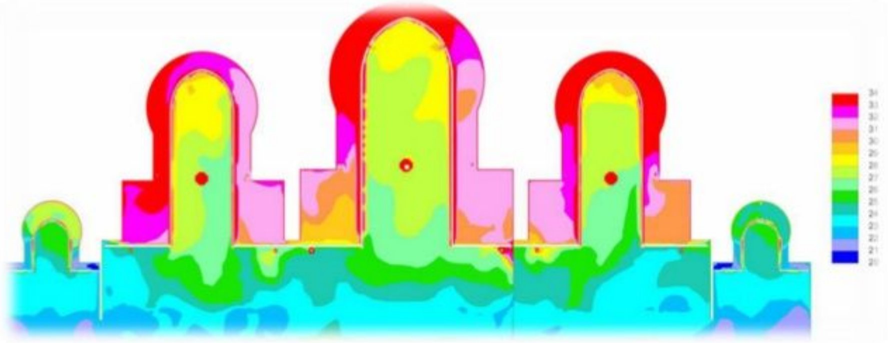
office_01.skp - SketchUp
Layer0
10/15
11:20 AM
Sefaira Plugin
sefaira for SketchUp
Real Time Analysis
Office
in
Boston
Total Floor Area
101,341
Energy Use
Intensity (KBTU/ft²/yr)
45
Total (MMBTU/yr)
4,606
Heat Flows into Building
Heat Flows out of Building
Others
Appliance
Lighting
HVAC Heating
South Solar
Ventilation
Ventilation
HVAC Cooling
Glazing Conduction
Infiltration
Wall Conduction
Roof Conduction
Floor Conduction
www.sefaira.com

IES

Sheik Zayad Mosque, Abu Dhabi, UAE



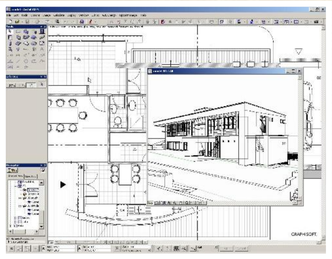
IES were appointed to conduct thermal simulation analysis of the mosque using their building analysis software to determine internal thermal comfort conditions, optimise HVAC system performance and verify building safety.



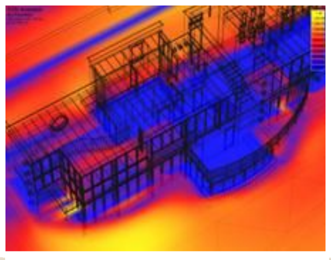
Ecodesigner "Energy Analysis with ArchiCAD"

ecodesigner

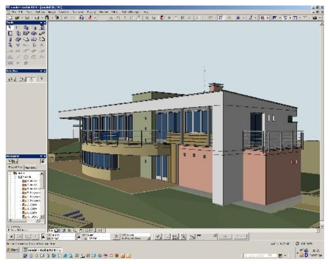
- Ease-of-use and smooth workflow
- Integrated solutions
- Evaluate alternatives early and throughout the design process



GRAPHISOFT ARCHICAD



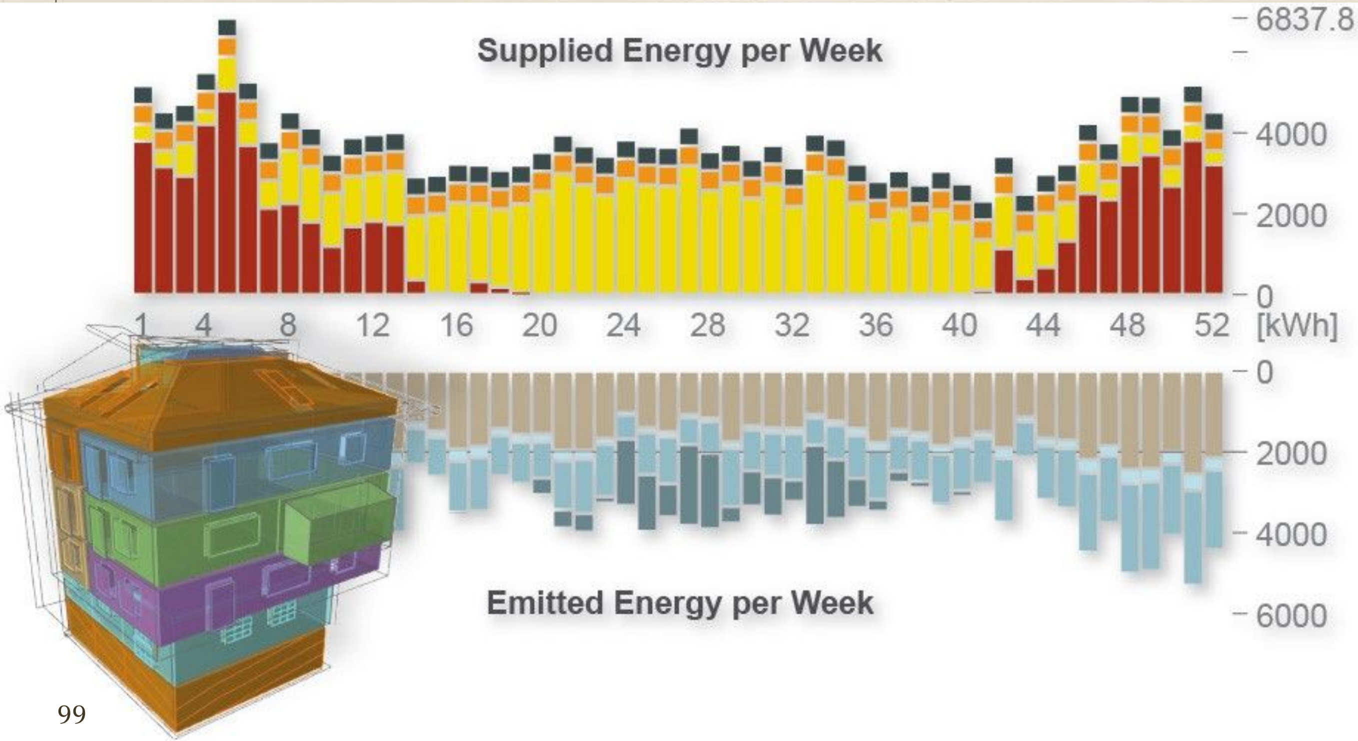
Energy simulation solutions



GRAPHISOFT ARCHICAD

Detailed Energy Performance Evaluation Report

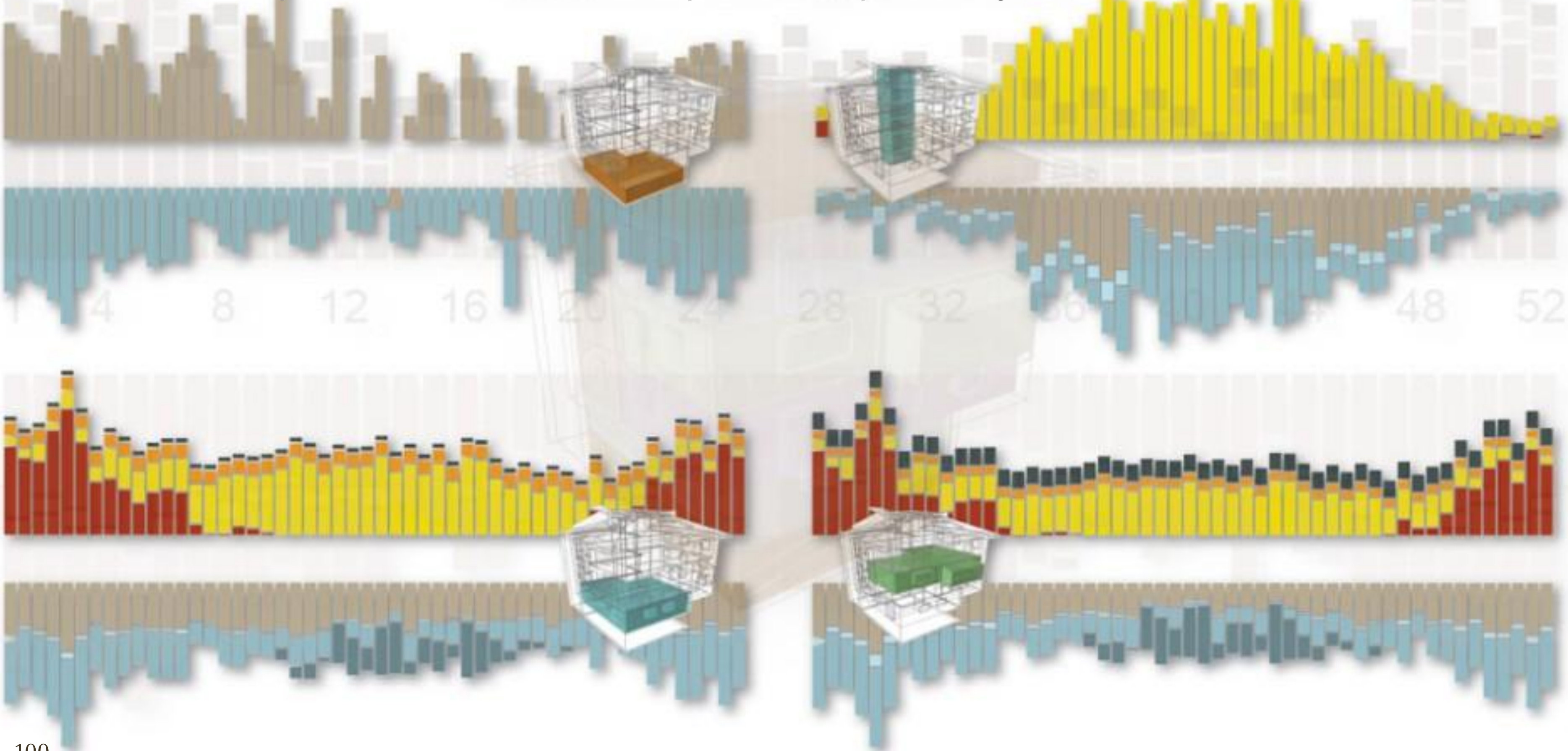
EcoDesigner STAR displays fully customizable, detailed reports about various, energy-related characteristics of the individual thermal blocks,

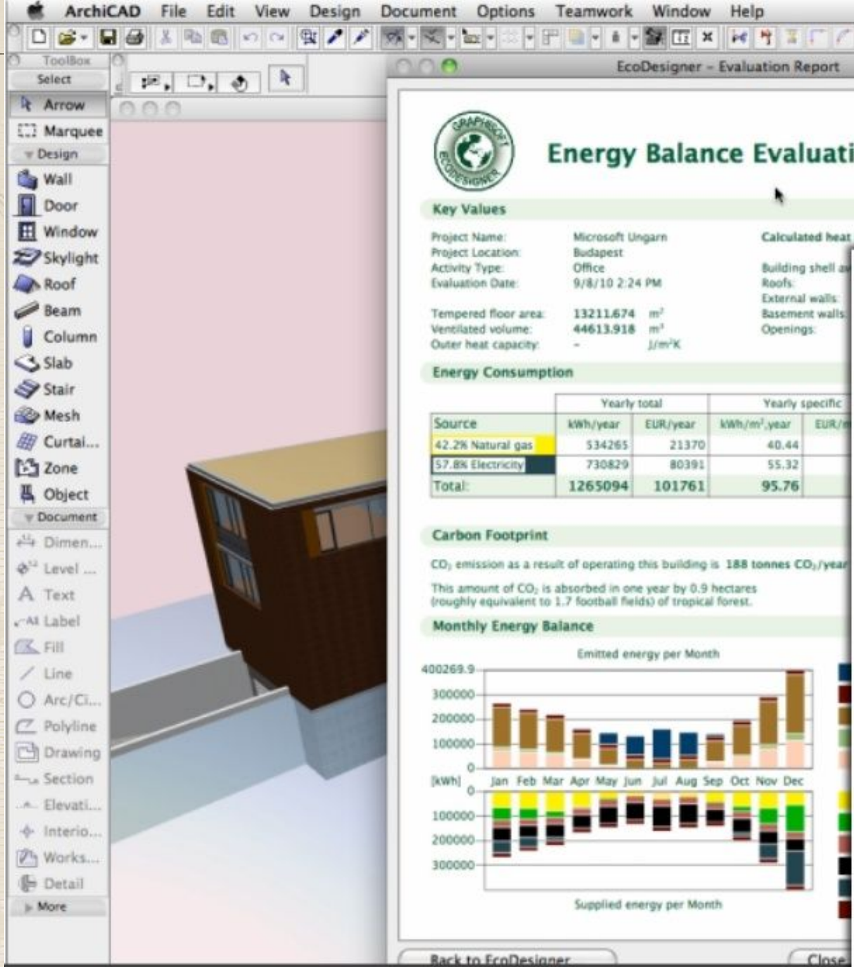




Detailed Energy Performance Monitor the entire project's energy performance.

Control and optimize the behavior of spaces independently.





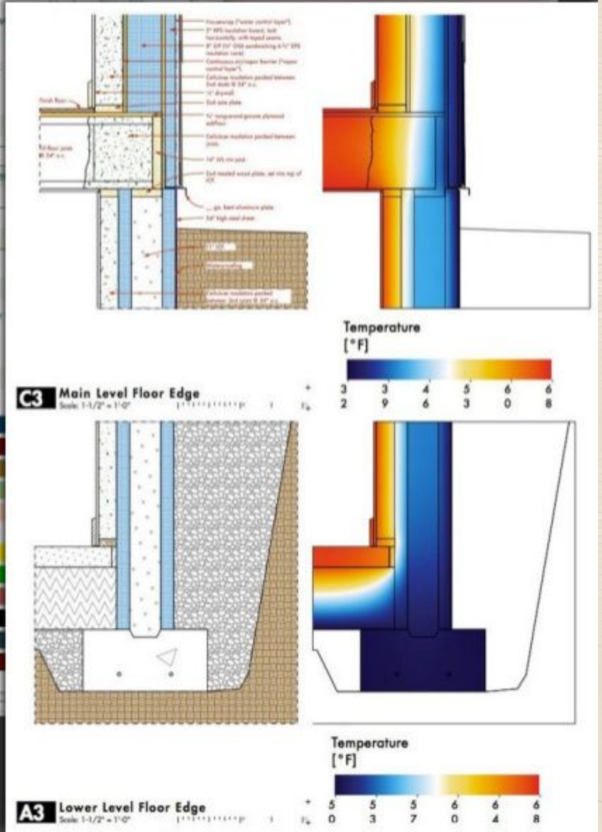
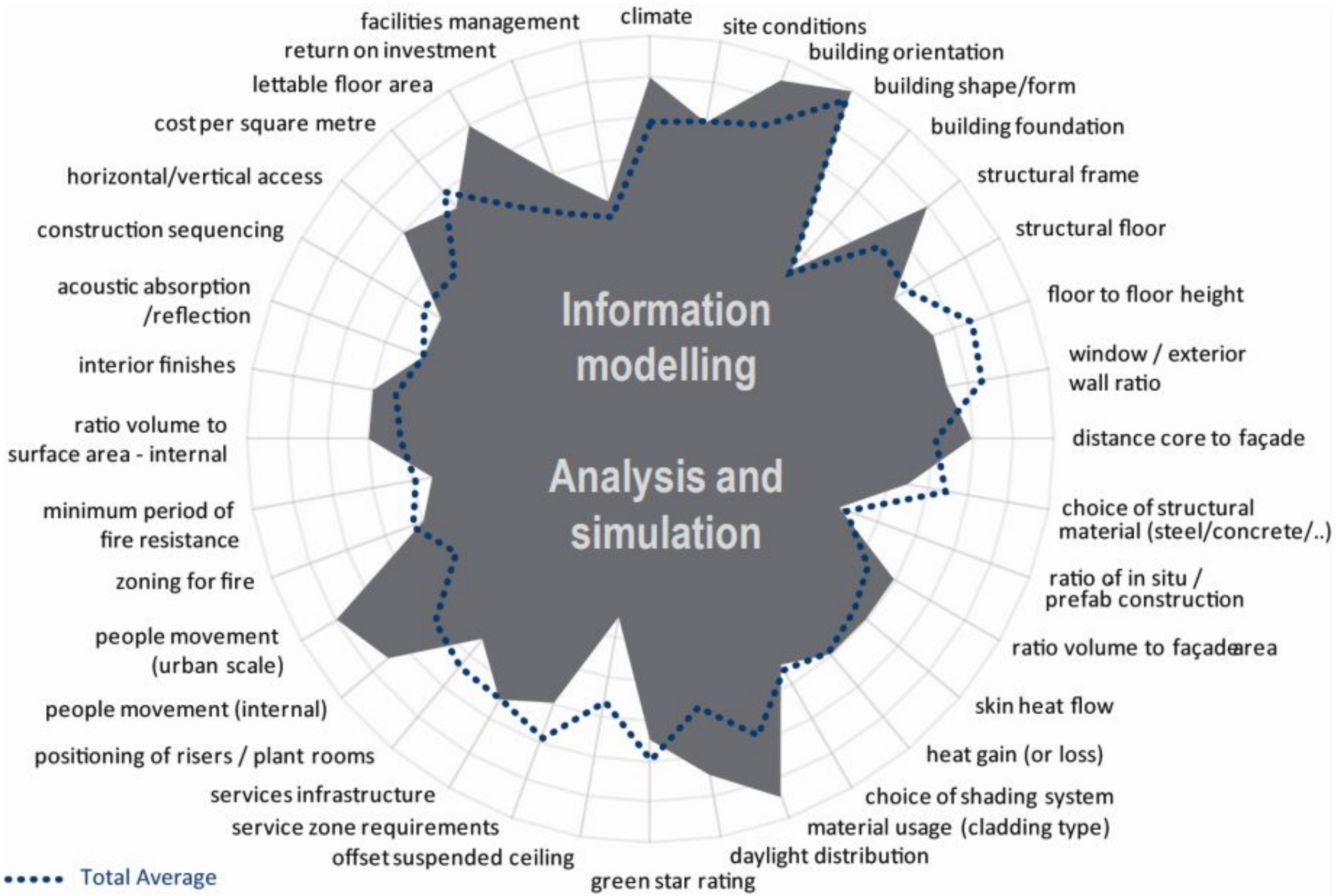


Image: www.graphisoft.com

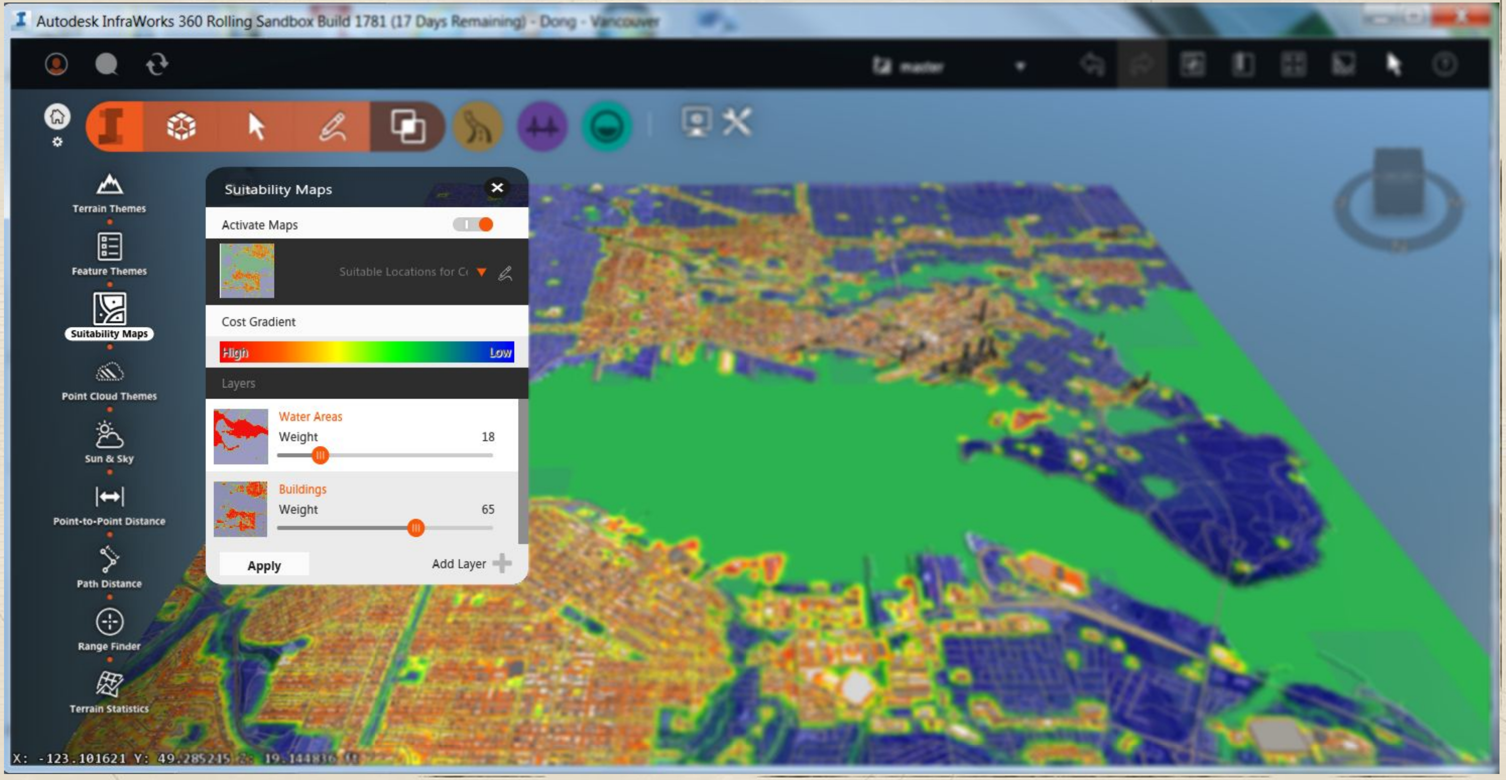
BENTLEY

Energy analysis - AECOsim Energy Simulator




facilities management
climate
site conditions
return on investment
building orientation
lettable floor area
building shape/form
cost per square metre
building foundation
horizontal/vertical access
structural frame
construction sequencing
structural floor
acoustic absorption /reflection
floor to floor height
Information modelling
window / exterior wall ratio
interior finishes
ratio volume to surface area - internal
distance core to façade
Analysis and simulation
minimum period of fire resistance
choice of structural material (steel/concrete/..)
zoning for fire
ratio of in situ / prefab construction
people movement (urban scale)
ratio volume to façade area
people movement (internal)
skin heat flow
positioning of risers / plant rooms
heat gain (or loss)
services infrastructure
choice of shading system
service zone requirements
material usage (cladding type)
offset suspended ceiling
daylight distribution
green star rating
Total Average

Suitability Maps for InfraWorks 360



Suitability Maps for InfraWorks 360



Suitability Maps for InfraWorks 360

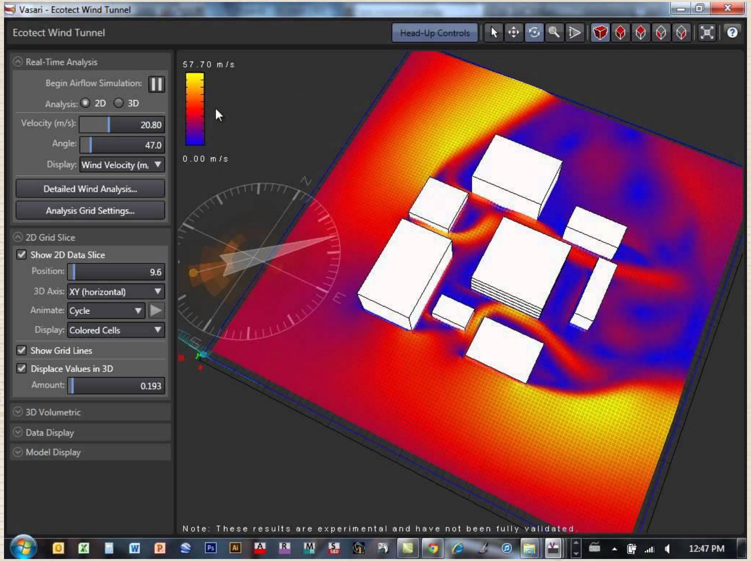


Software

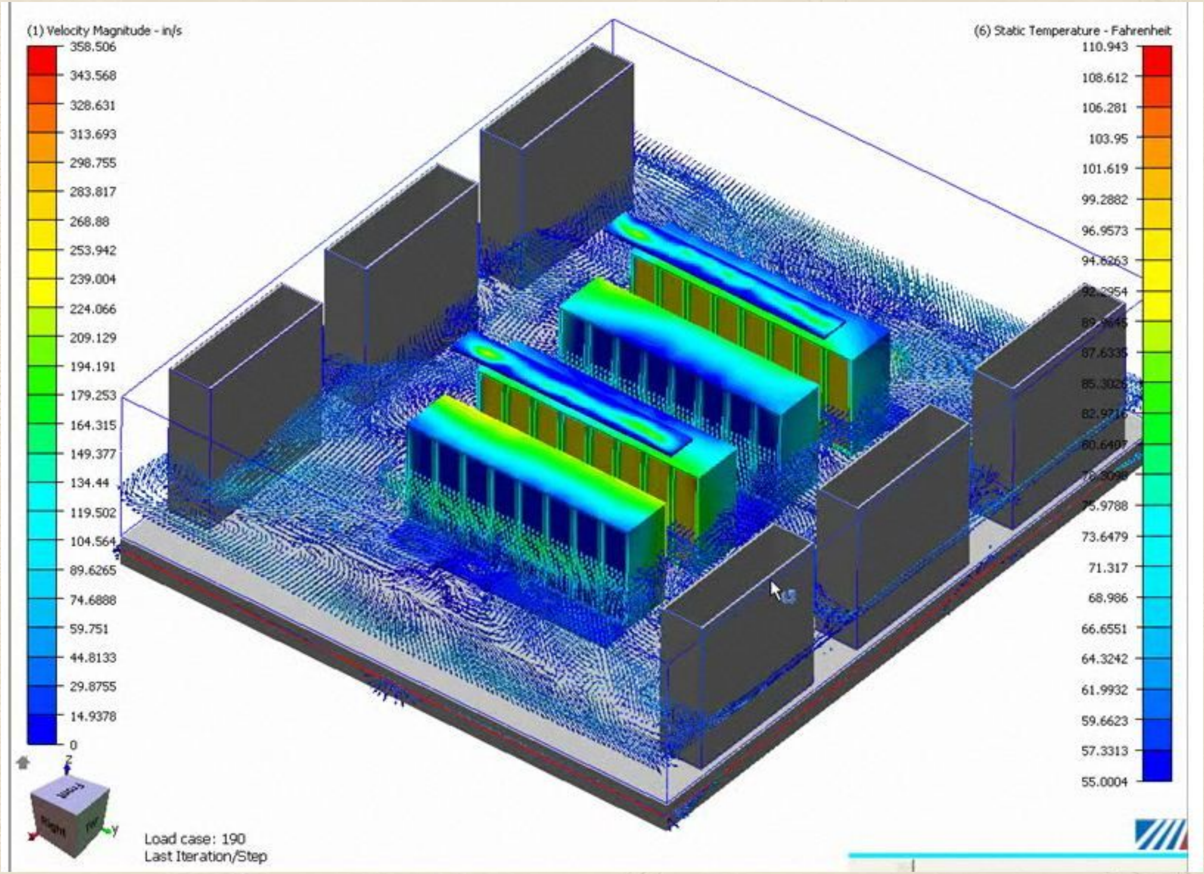
Applications: Autodesk Vasari

- conceptual building design (parametric massing) and provides energy/carbon analysis,solar radiation analysis, and more, you can create, analyze, and refine whole building models.

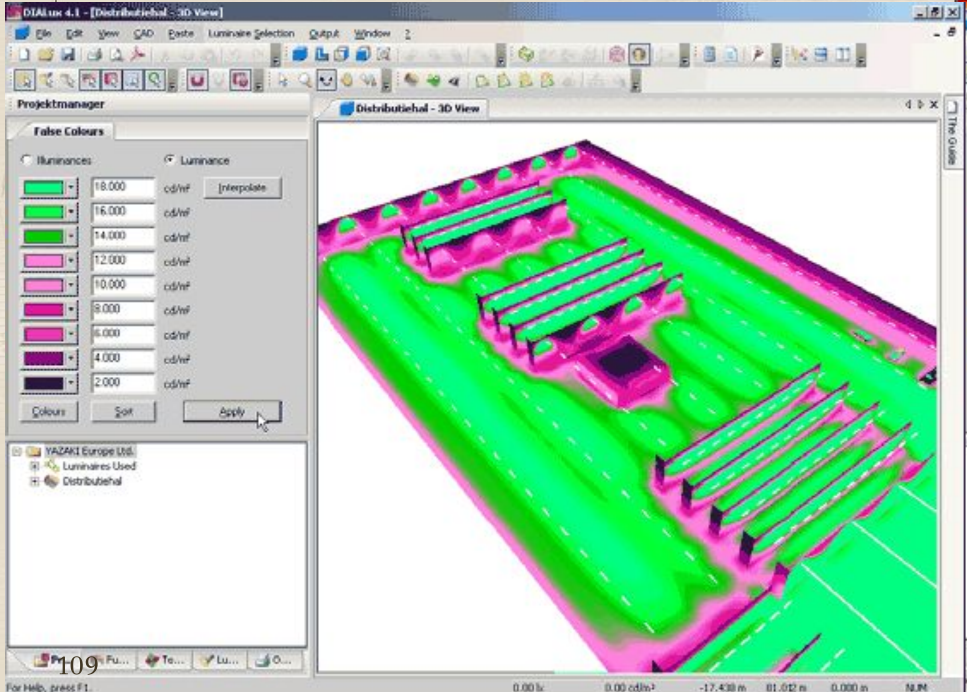
- Conceptual building models created with Vasari can also be used in Autodesk Revit to develop more detailed building models.

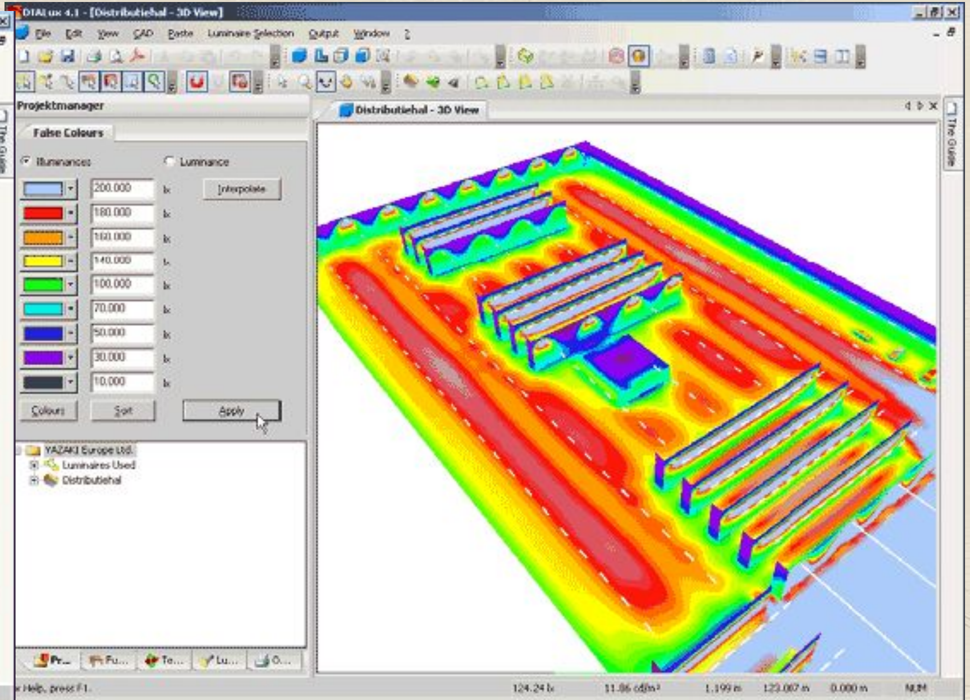


Autodesk CFD



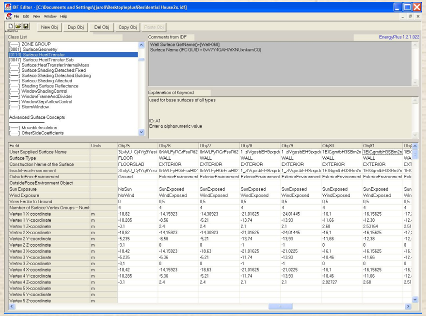
Dialux

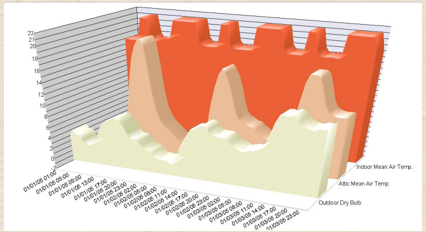

DIALux 4.1 - [Distributiehal - 3D View]
Projektmanager
False Colours
Illuminances
Luminance
Interpolate
Colours
Sort
Apply
YAZAKI Europe Ltd.
Luminaires Used
Distributiehal
Distributiehal - 3D View


DIALux 4.1 - [Distributiehal - 3D View]
Projektmanager
False Colours
Illuminances
Luminance
Interpolate
Colours
Sort
Apply
YAZAKI Europe Ltd.
Luminaires Used
Distributiehal
Distributiehal - 3D View

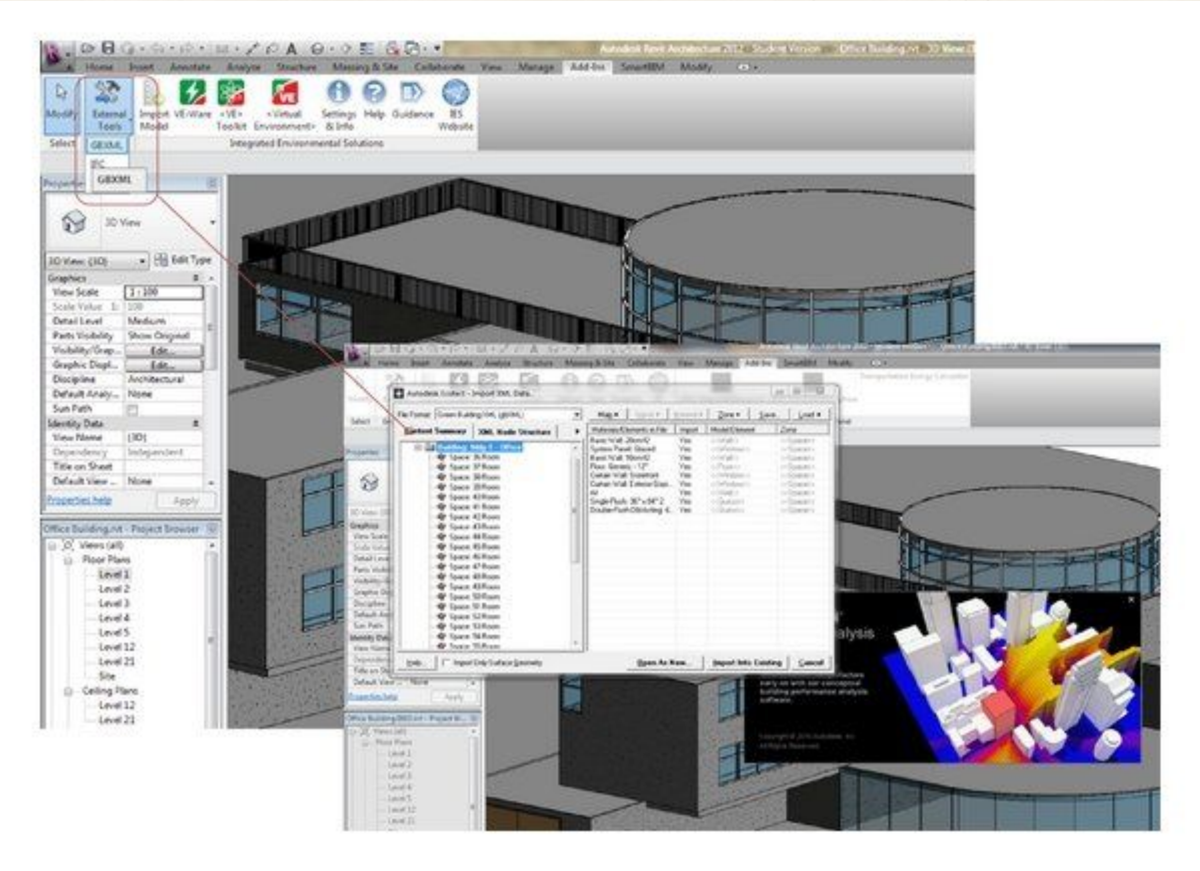
Applications: ECOTECT

- Fully integrated building & HVAC program for architects, engineers, and researchers
- Stand-alone engine without a graphical interface
- Reads input and writes output as text files
- Simulates
  building heating,
  cooling,
  lighting,
  ventilating,
  and other energy flows
- Results
  Load Calculations
  Energy Analysis
  Indirect environmental effects

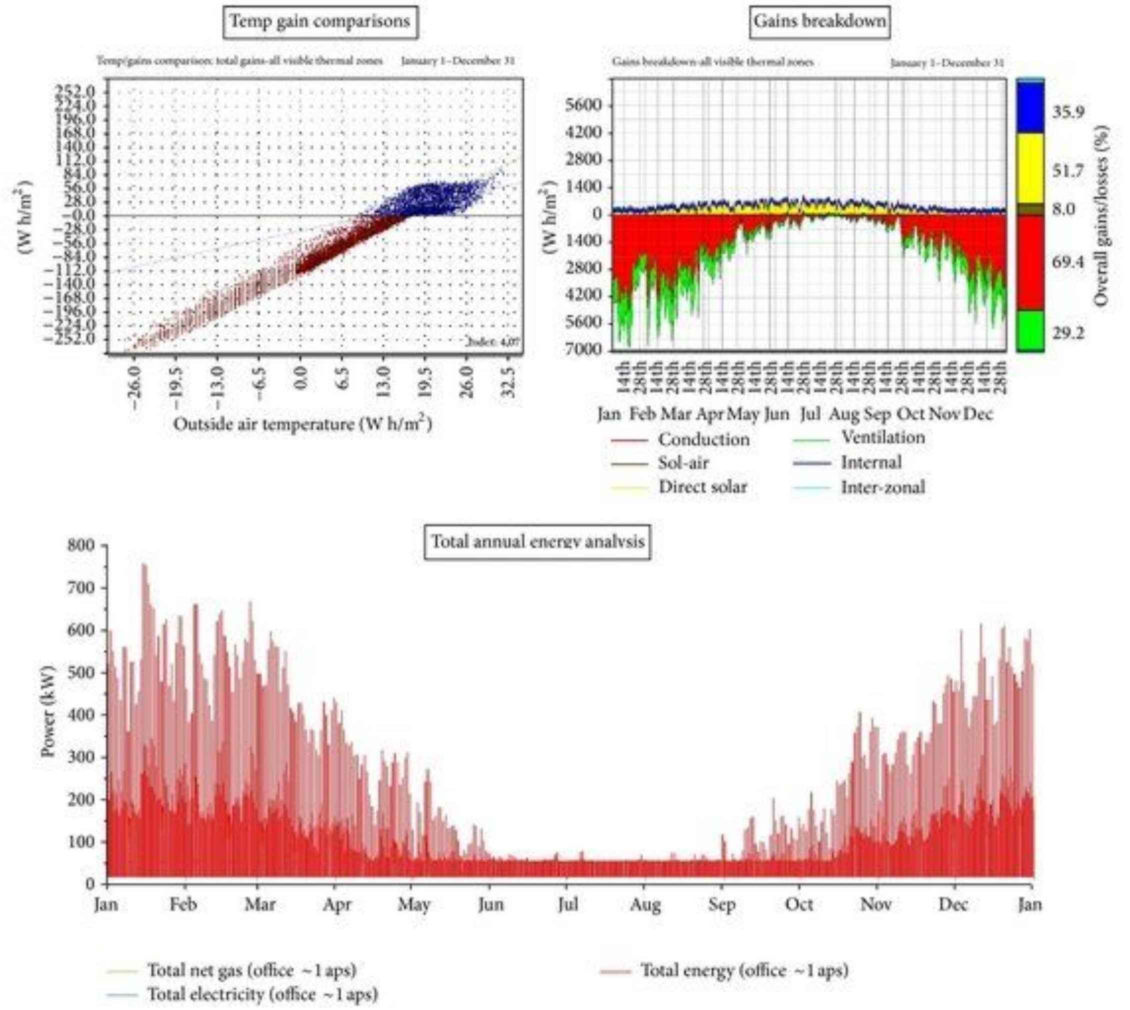




directly transferring BIM model to Ecotect via plug-in based on gbXML file format.

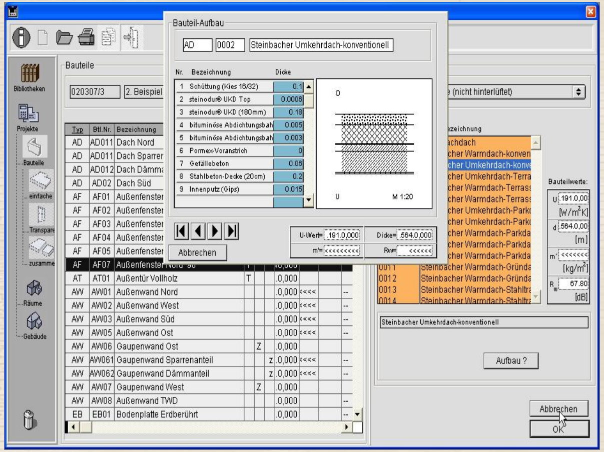


sample thermal energy analysis in Ecotect.



Applications: ArchiPHYSIK

- A complete solution for thermal analysis including U-value, vapor diffusion and temperature amplitudes.
- Identifies failures compared to pre-defined values.
- Building performance
- Building component performance

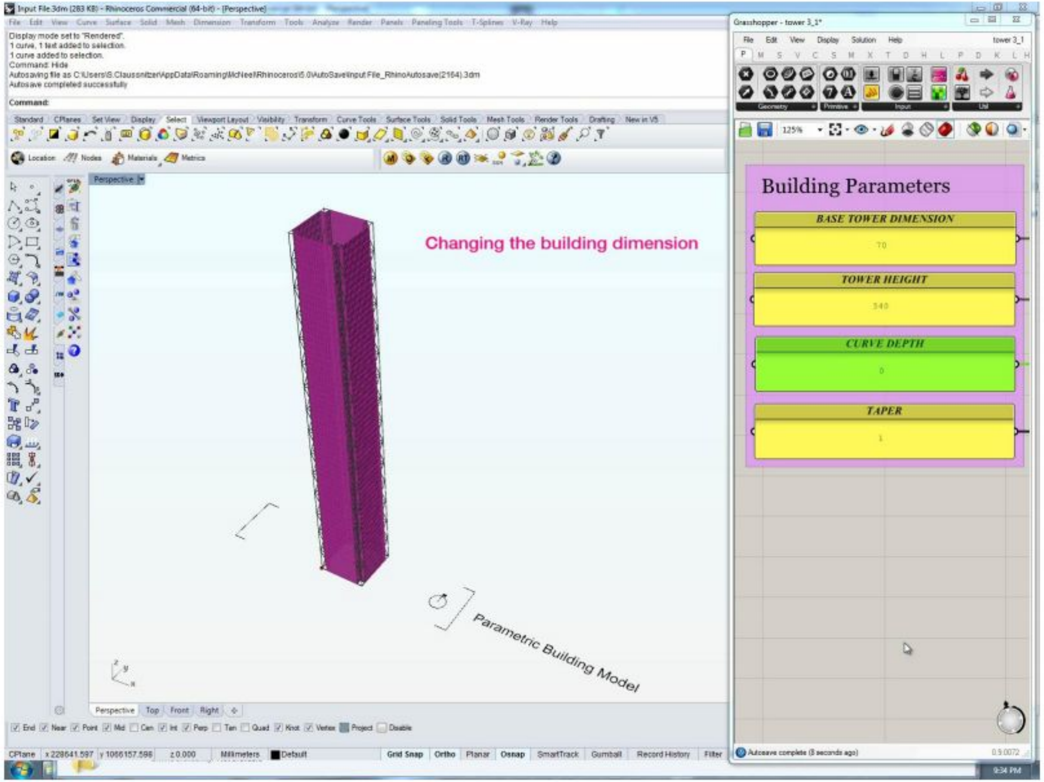


Software

Rhino
Grasshopper

INTEGRATED DATA MODEL

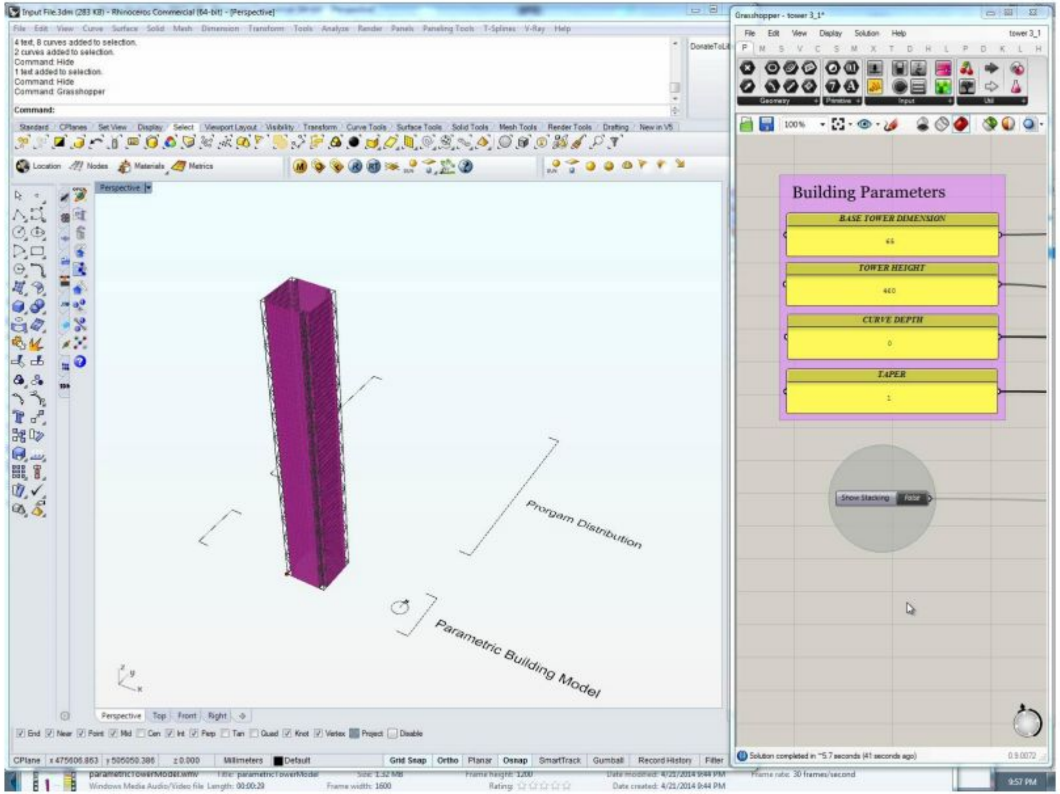
INTEGRATED DESIGN INTENT



PARAMETRIC BUILDING MODEL WITH ENCODED DESIGN INTENT

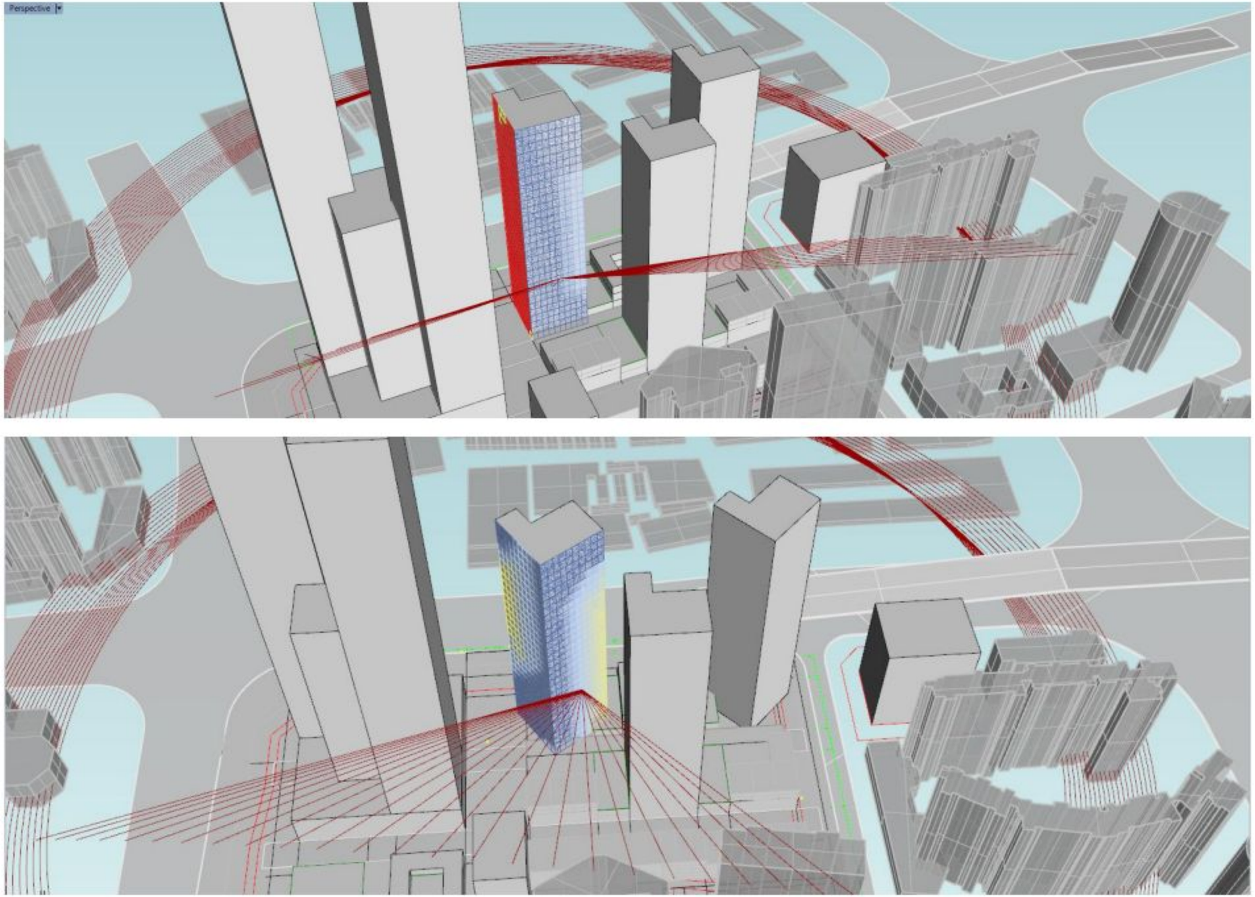
INTEGRATED DATA MODEL

PROGRAM VALIDATION



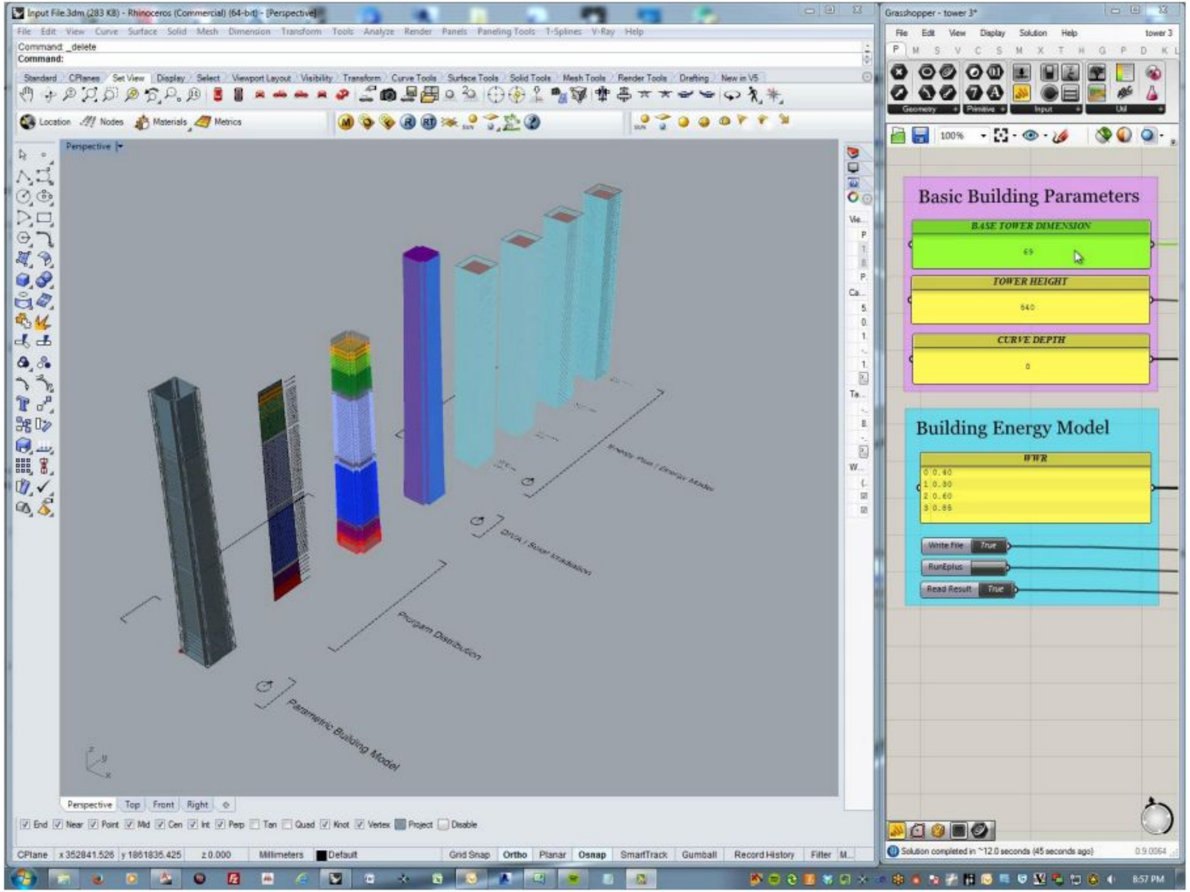
PARAMETRIC BUILDING MODEL UNDERSTANDS PLANING CONSTRAINTS

INTEGRATED DATA MODEL
CODE CHECKING



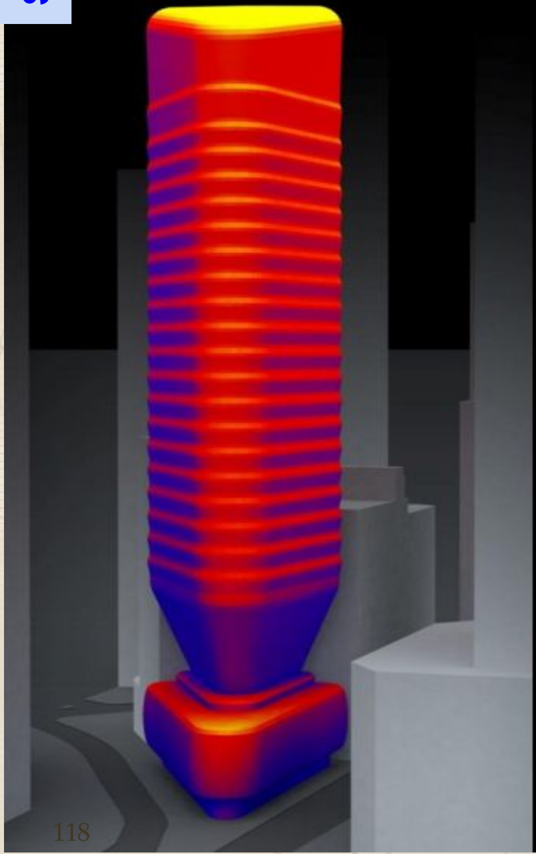
INTEGRATED DATA MODEL

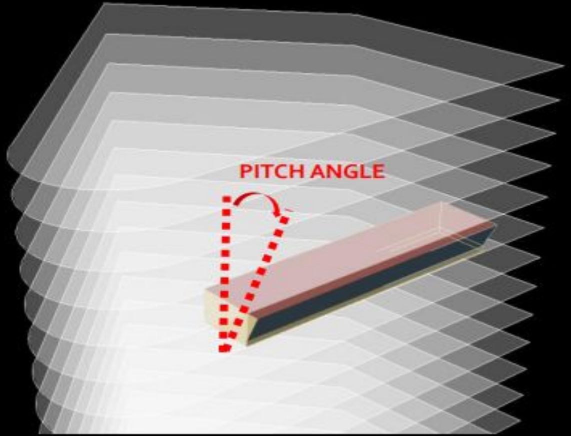
INTEGRATED ENVIRONMENTAL ANALYSIS

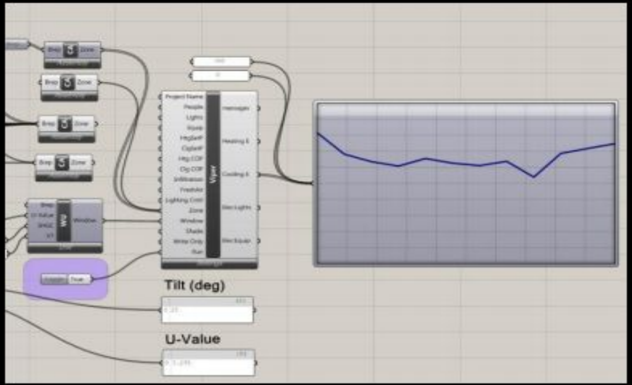


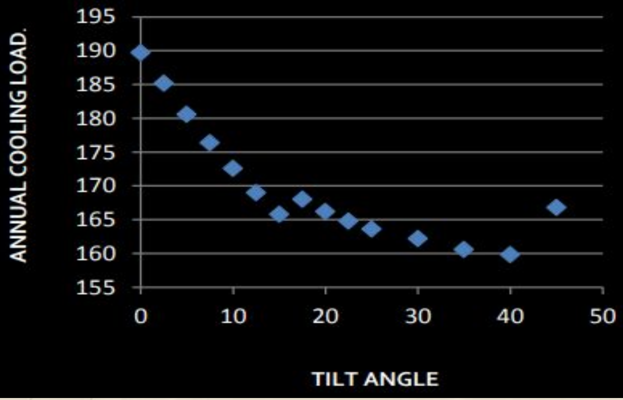
INTEGRATED DATA MODEL

PARAMETRIC ENERGY ANALYSIS



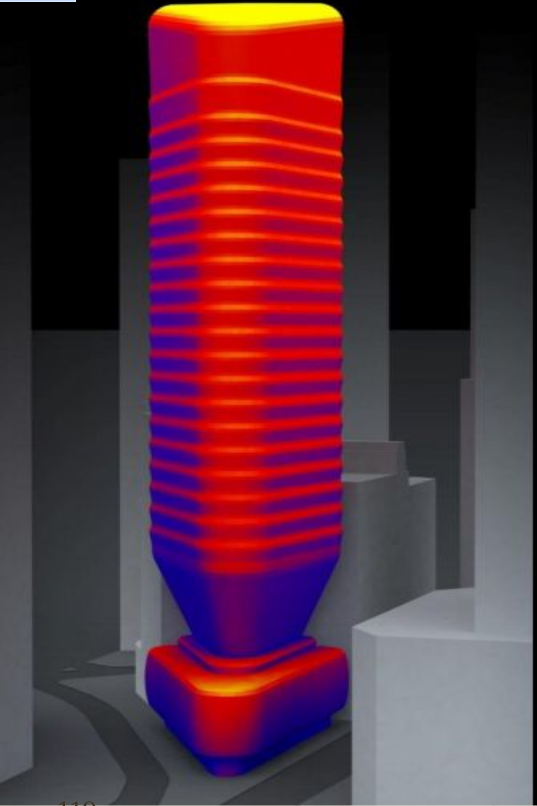


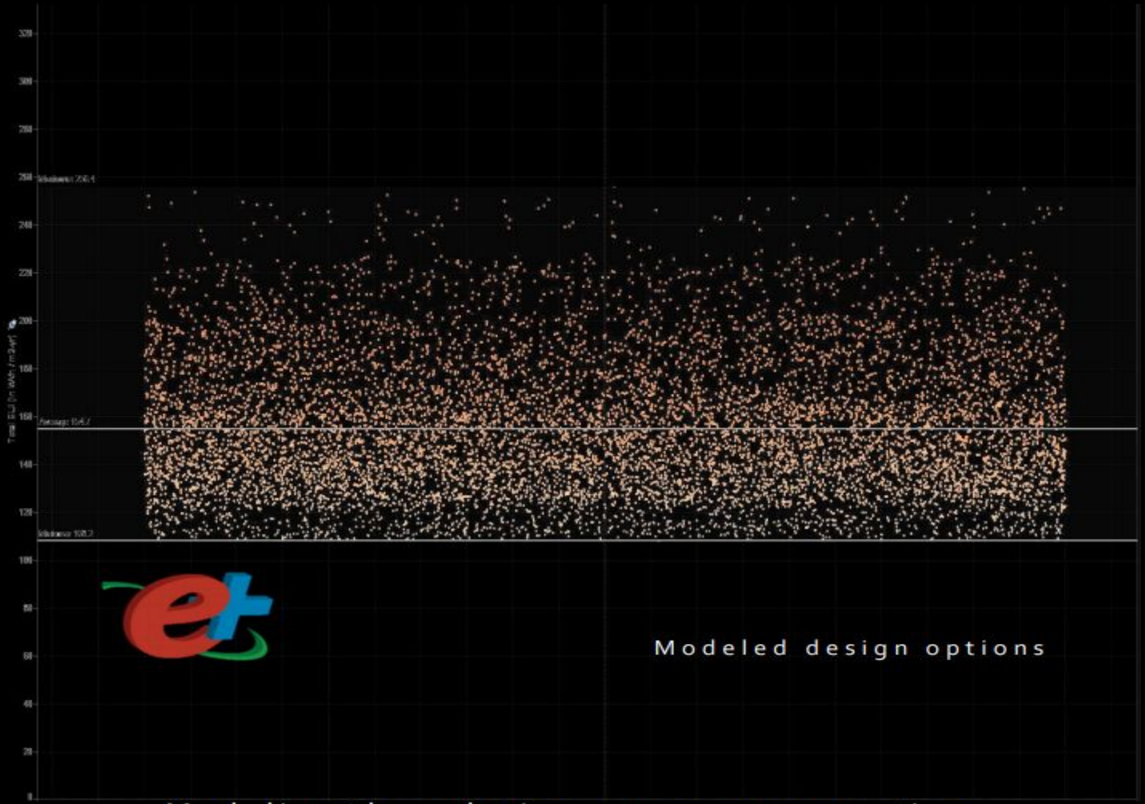




INTEGRATED DATA MODEL

PARAMETRIC ENERGY ANALYSIS

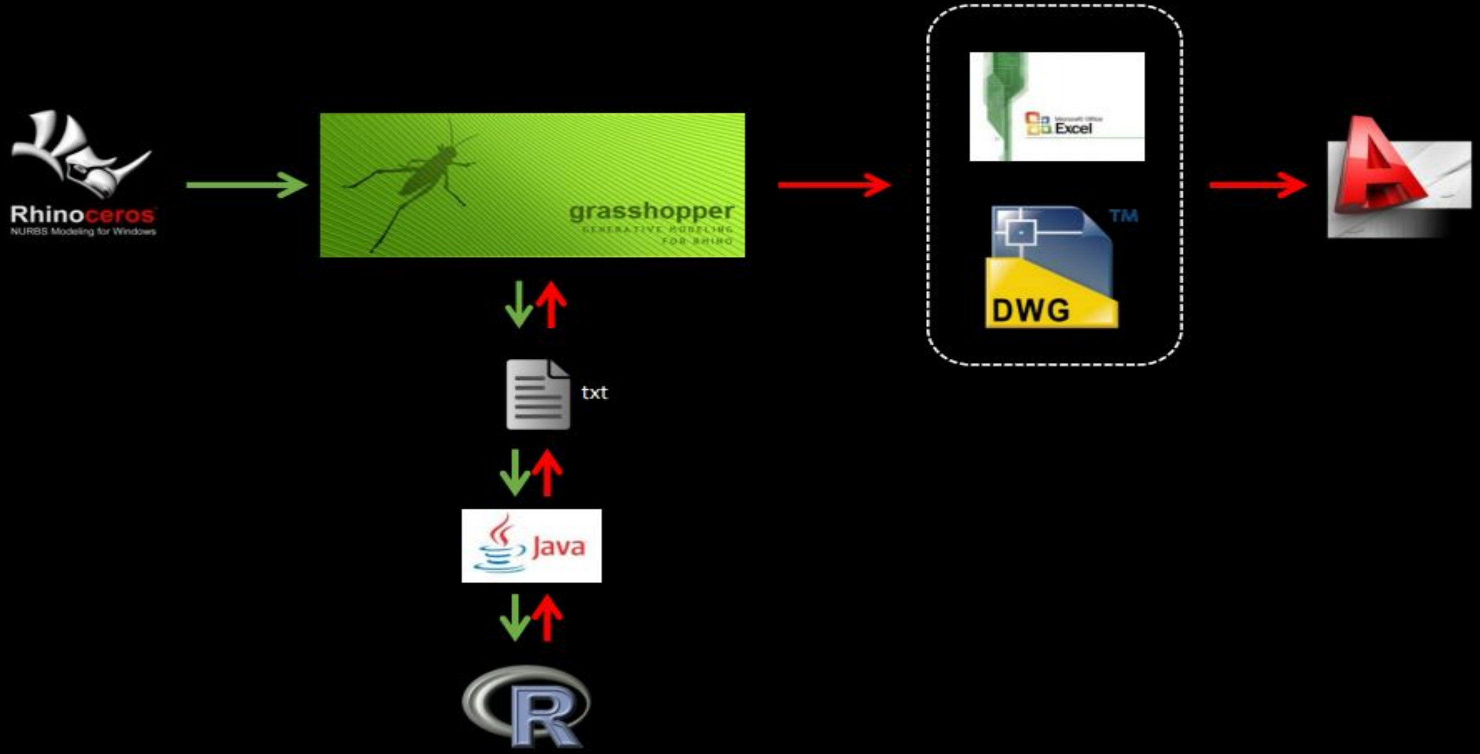




Modeling the solution space ~9,000 options

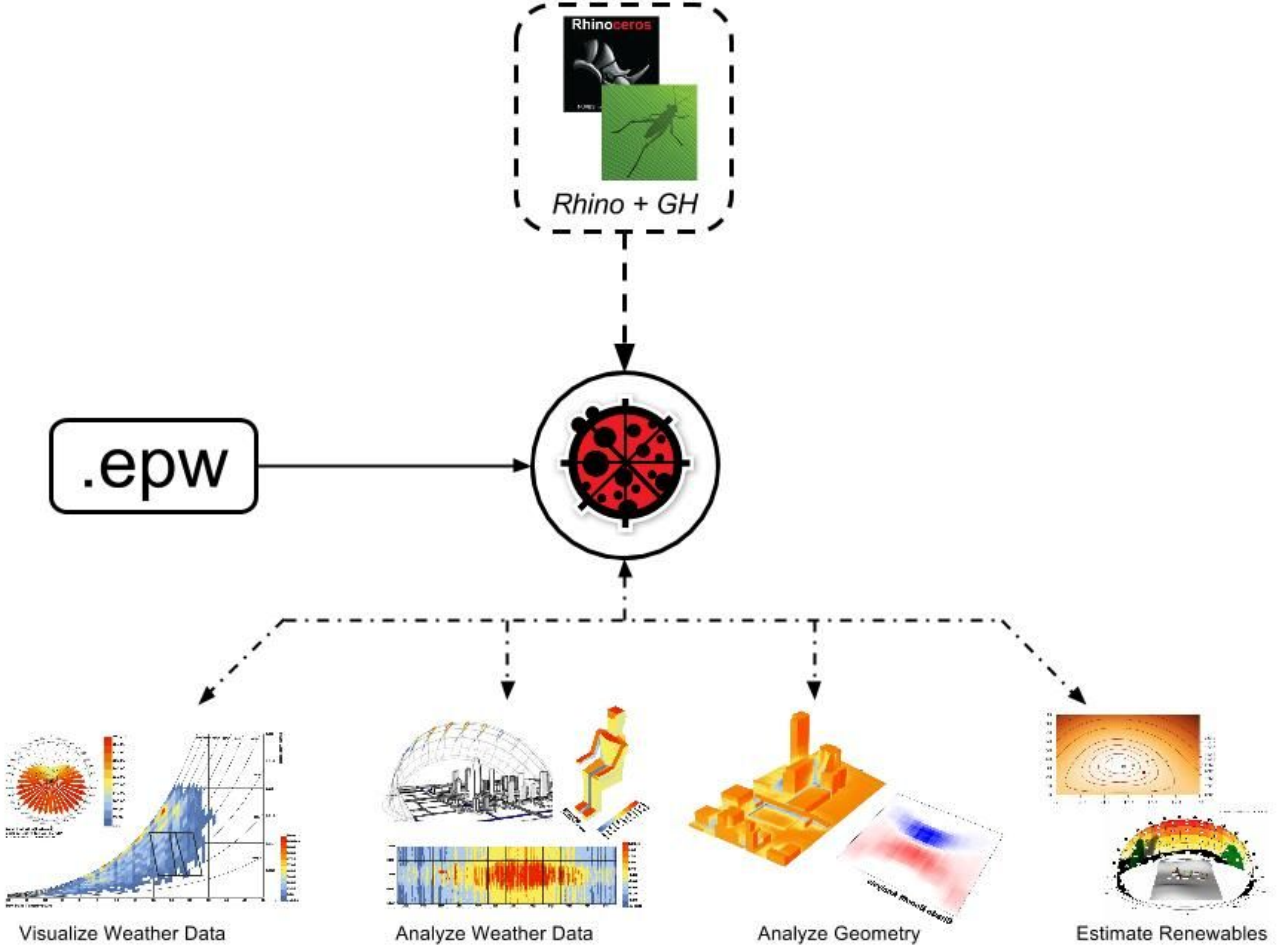
INTEGRATED DATA MODEL

DATA INTER-PLATFORM COLLABORATION



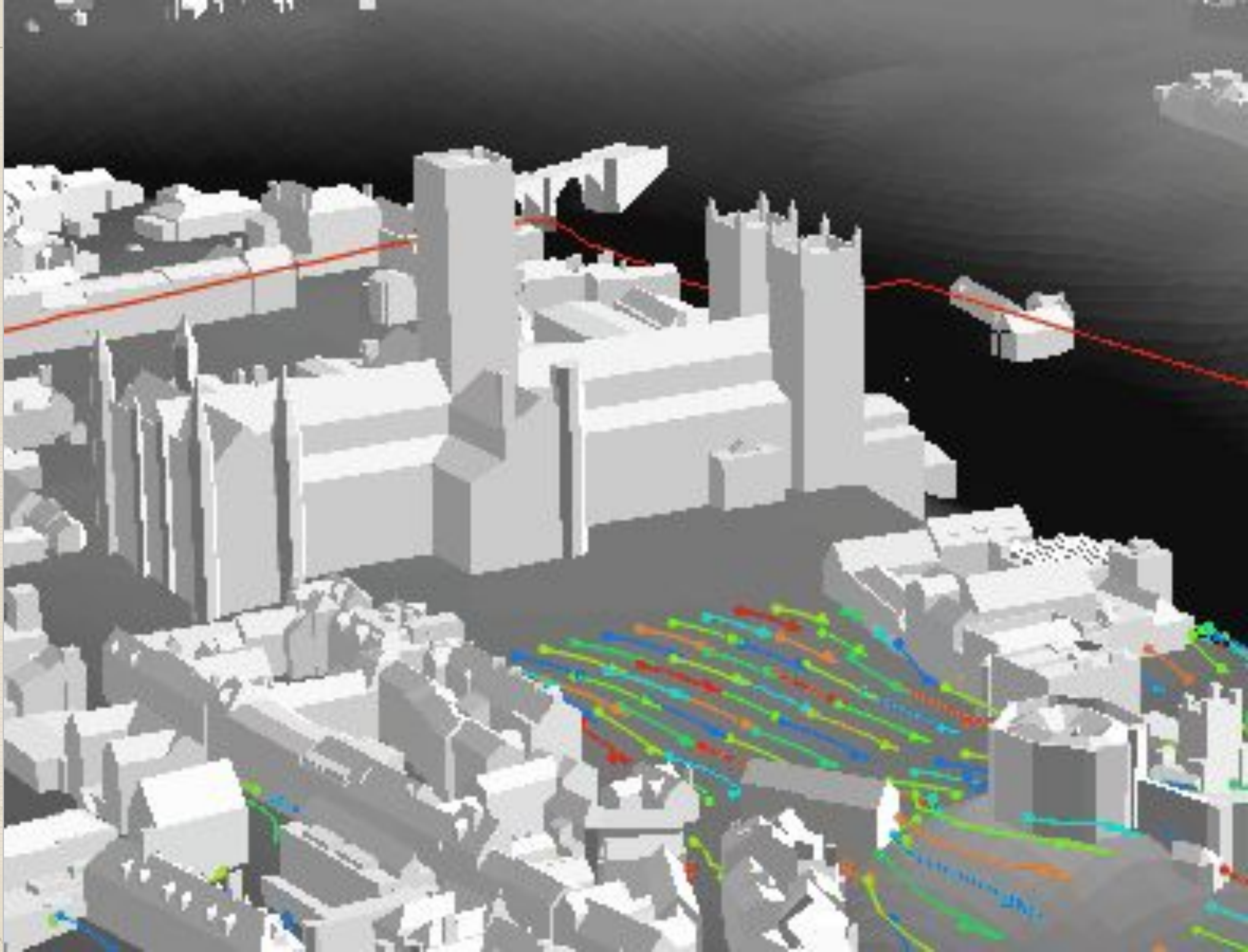
ladybug

Ladybug allows you to import and analyze standard weather data in Grasshopper; draw diagrams like Sun-path, wind-rose, radiation-rose, etc; customize the diagrams in several ways; run radiation analysis, shadow studies, and view analysis.



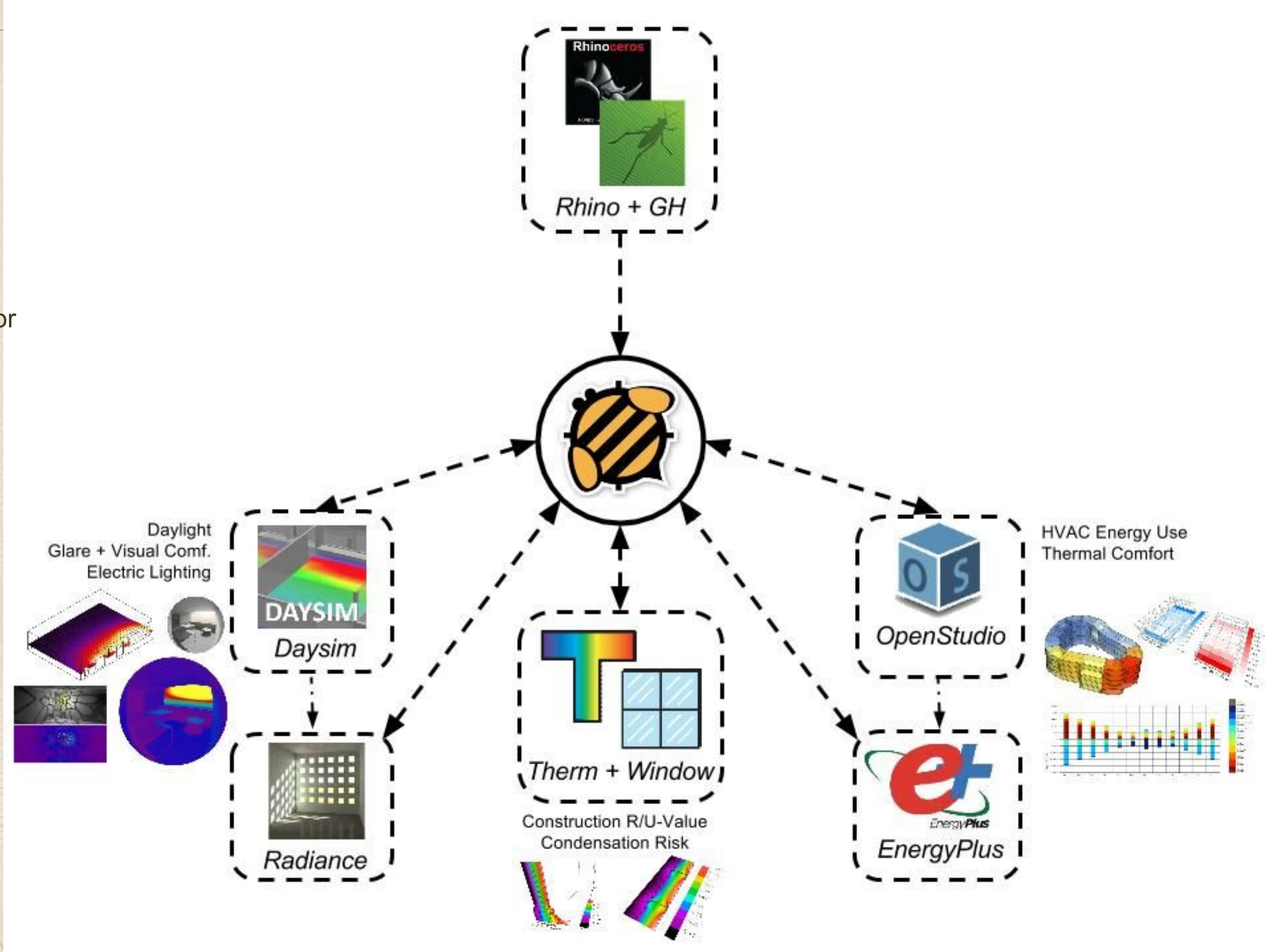
Butterfly

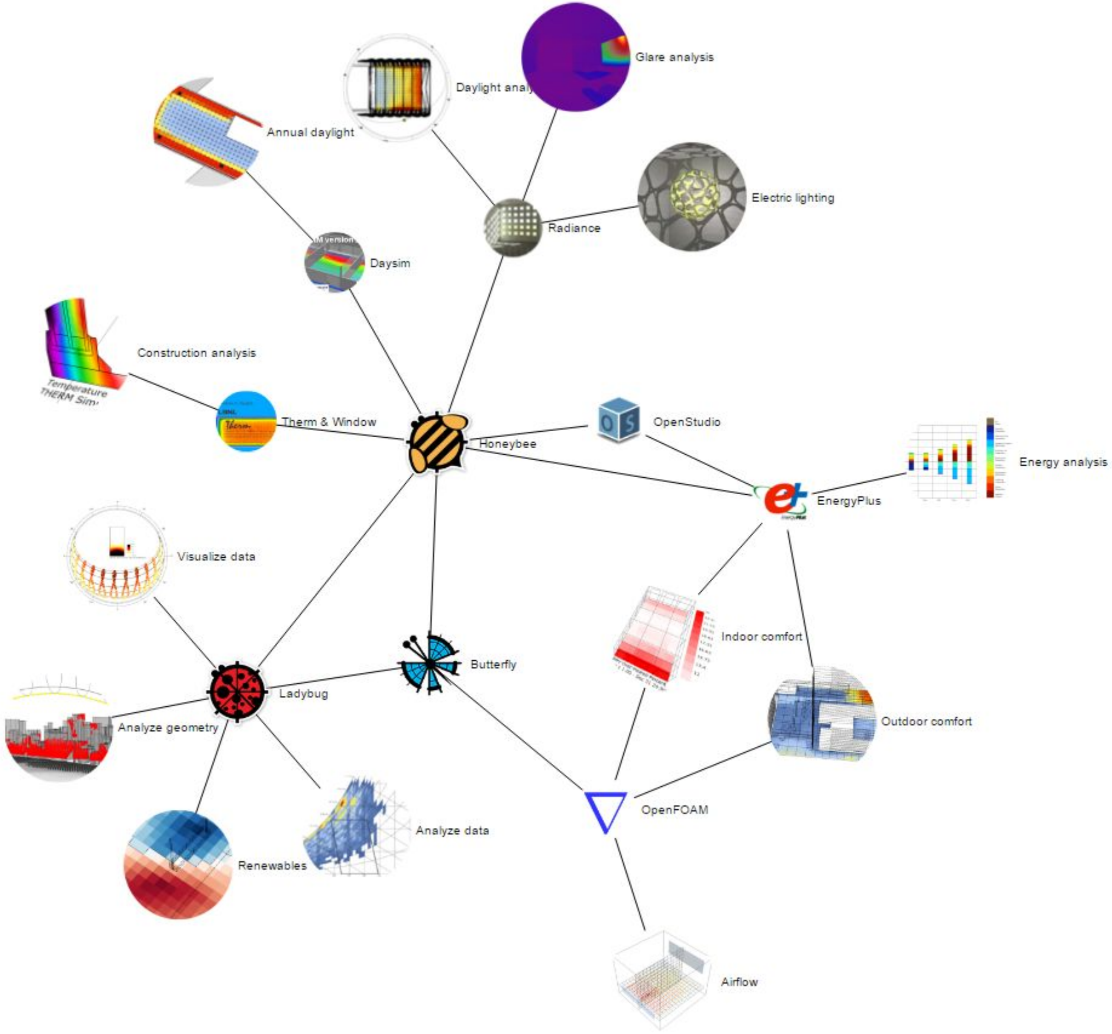
Butterfly is a Grasshopper/Dynamo plugin and object-oriented python library that creates and runs computational fluid dynamics (CFD) simulations using OpenFOAM.



Honeybee

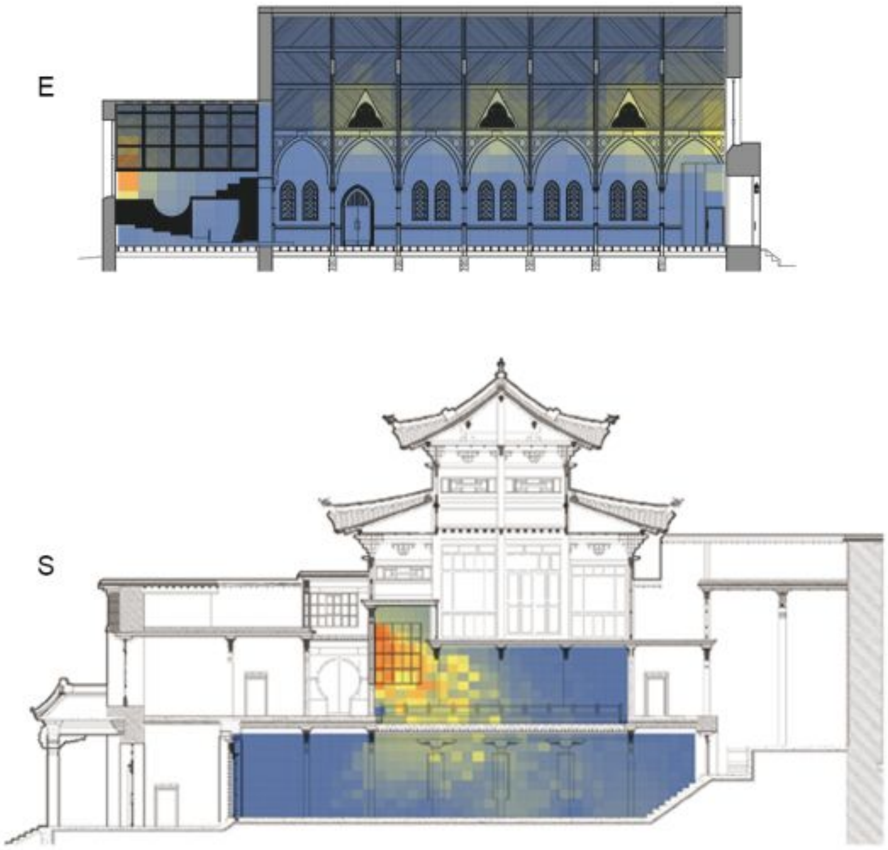
Honeybee connects Grasshopper3D to validated simulation engines such as EnergyPlus, Radiance, Daysim and OpenStudio for building energy, comfort, daylighting and lighting simulation.



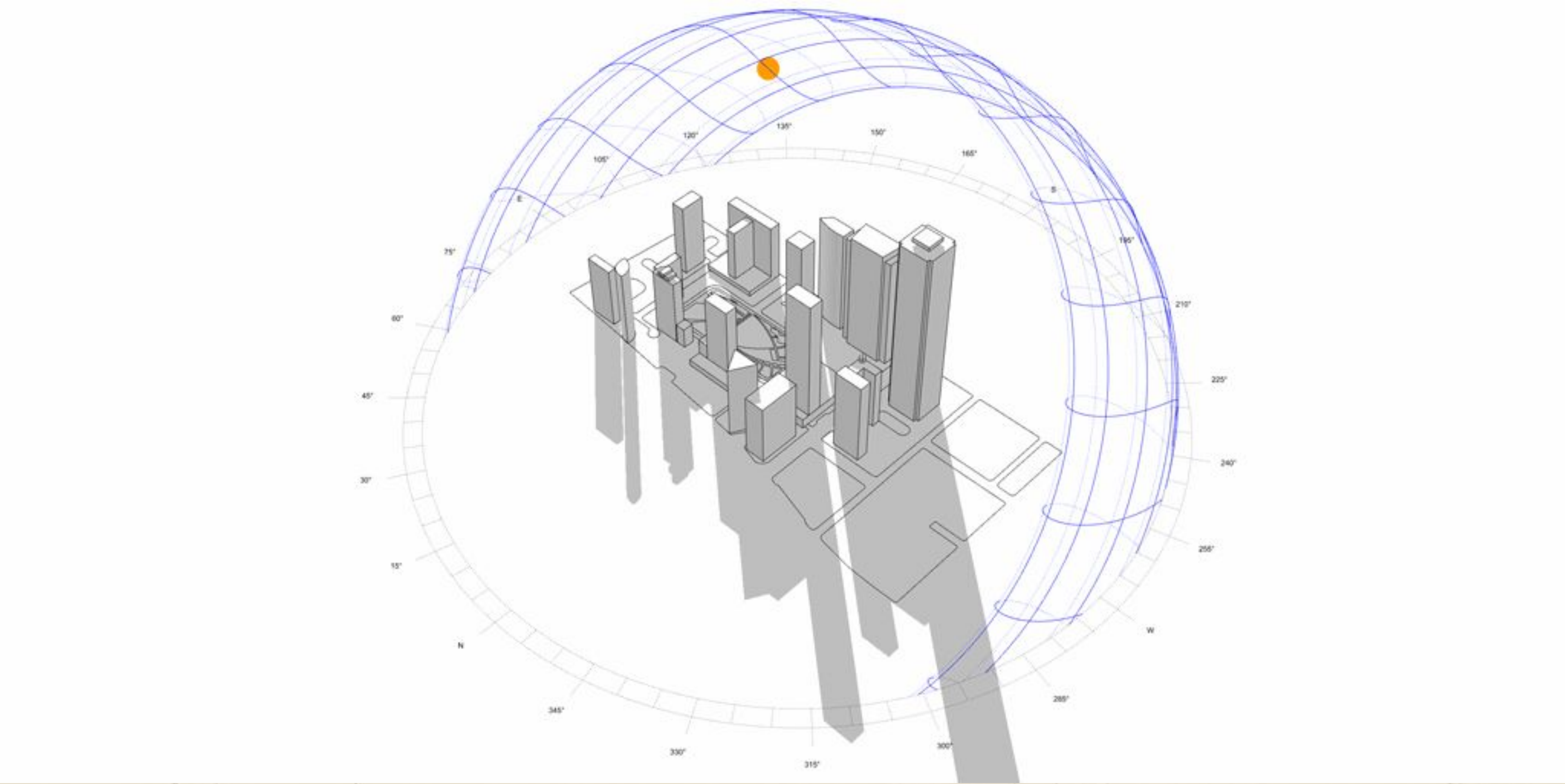

Glare analysis
Daylight anal
Annual daylight
Electric lighting
Radiance
Daysim
Construction analysis
Temperature
THERM Sim
Therm & Window
OpenStudio
Honeybee
Energy analysis
EnergyPlus
Visualize data
Indoor comfort
Butterfly
Ladybug
Outdoor comfort
Analyze geometry
OpenFOAM
Analyze data
Renewables
Airflow

DIVA-for-Rhino

- Point in Time Visualization
- Daylight Factor
- Illuminance Distribution
- LEED Compliance
- Radiation Maps
- Spatial Daylight Autonomy
- Annual Solar Exposure

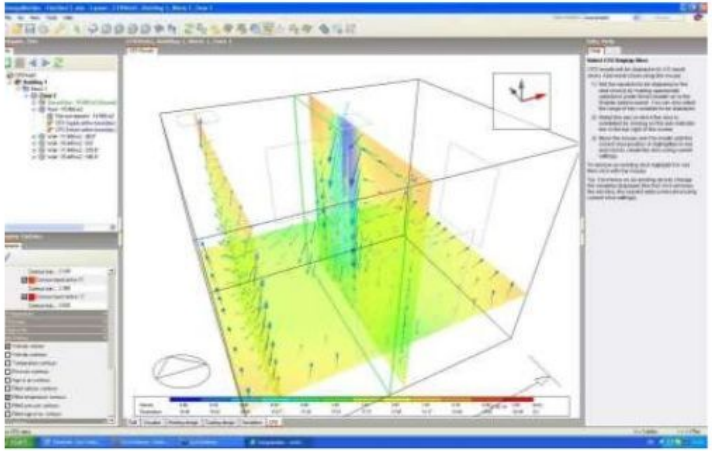


DIVA-for-Rhino



DesignBuilder

DesignBuilder, a whole building energy use analysis simulation tool, is the oldest, easiest to use, most powerful graphical user interface to EnergyPlus available and includes ASHRAE 90.1 Appendix G Baseline HVAC System templates, materials, and construction libraries



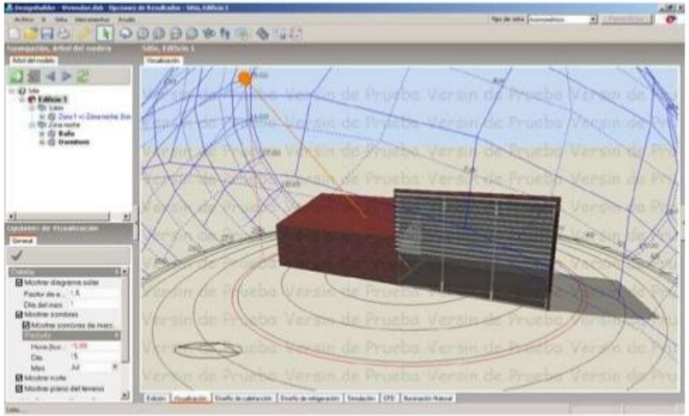
◆http://www.designbuilder.co.uk/

Note : This is good since we can change some or all input parameters and do more in-depth analysis, but it is bad for anyone who is not aware of the complexities of energy simulations. Plus you lose the ability to quickly compare different options within Revit.

DesignBuilder Packages for Architects

Solar calculations

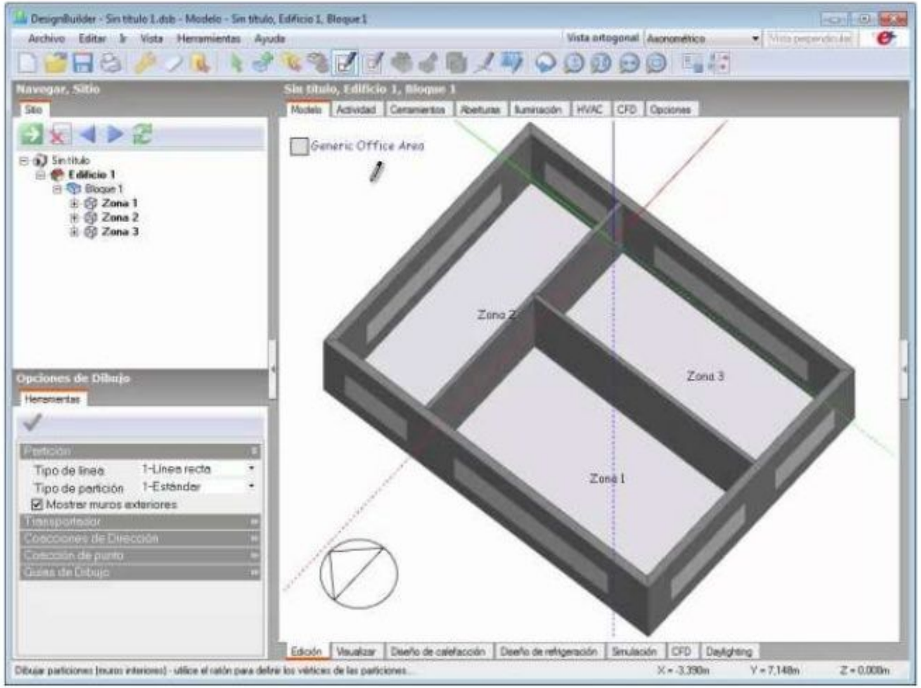
- The Architectural simulation packages allow you to link with BIM solutions, analyse solar shading, maximise the use of renewable technologies and test facade options all in one place, adjusting as you go according to client requirements.
- High quality technical and rendered outputs help communicate findings to clients in a way they can easily understand. Key performance indicators such as energy consumption, carbon emissions, thermal comfort, daylight availability and cost can be provided throughout the design process in both naturally ventilated and air-conditioned buildings.



Software

DesignBuilder Packages for Architects

Interactive rendered views, shading and walk-throughs



DesignBuilder Packages for Architects

Accurate daylighting calculations

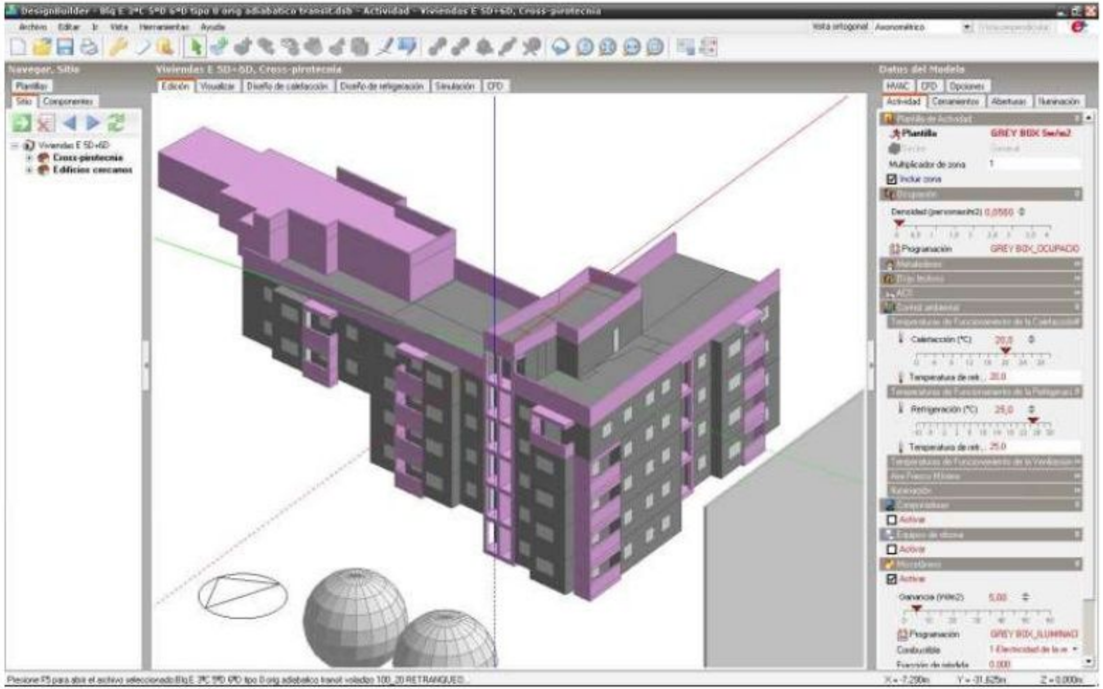
integrated generation of illuminance reports through Radiance



Software

DesignBuilder Packages for Architects

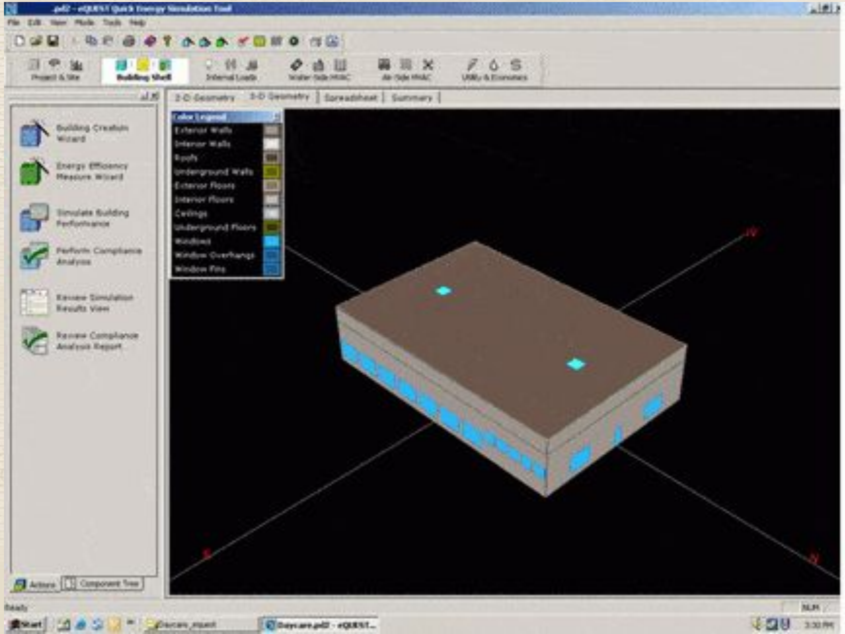
Import BIM models from Revit, SketchUp etc

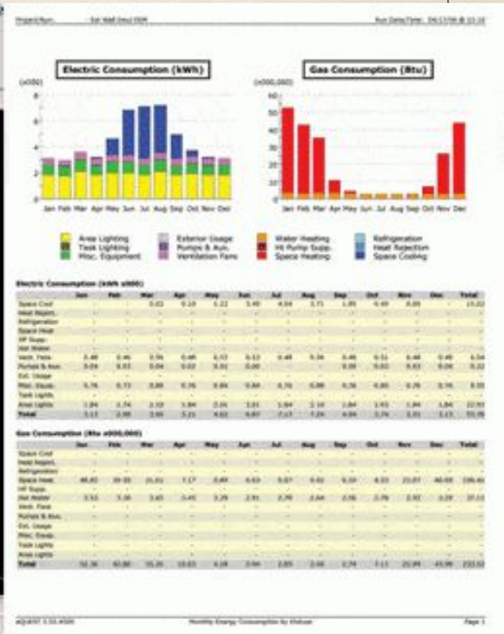


eQUEST

Imagine a building energy simulation tool comprehensive enough to be useful to ALL design team members, yet so intuitive ANY design team member could use it, in ANY or ALL design phases, including schematic design. eQUEST is well named because it provides something the you've been looking for, but have been unable to find … a sophisticated, yet easy-to-use building energy analysis tool. With eQUEST, you'll be able to provide professional-level results in an affordable level of effort.

-Daylight

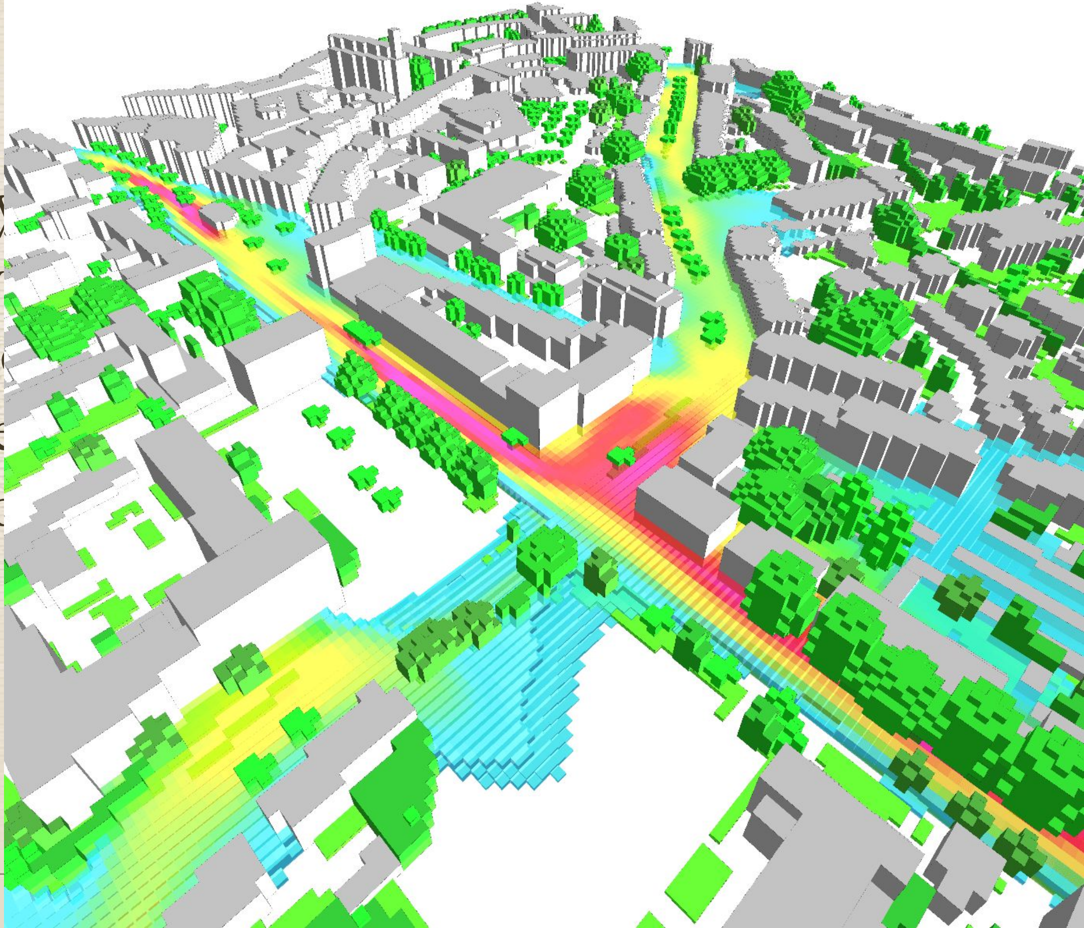


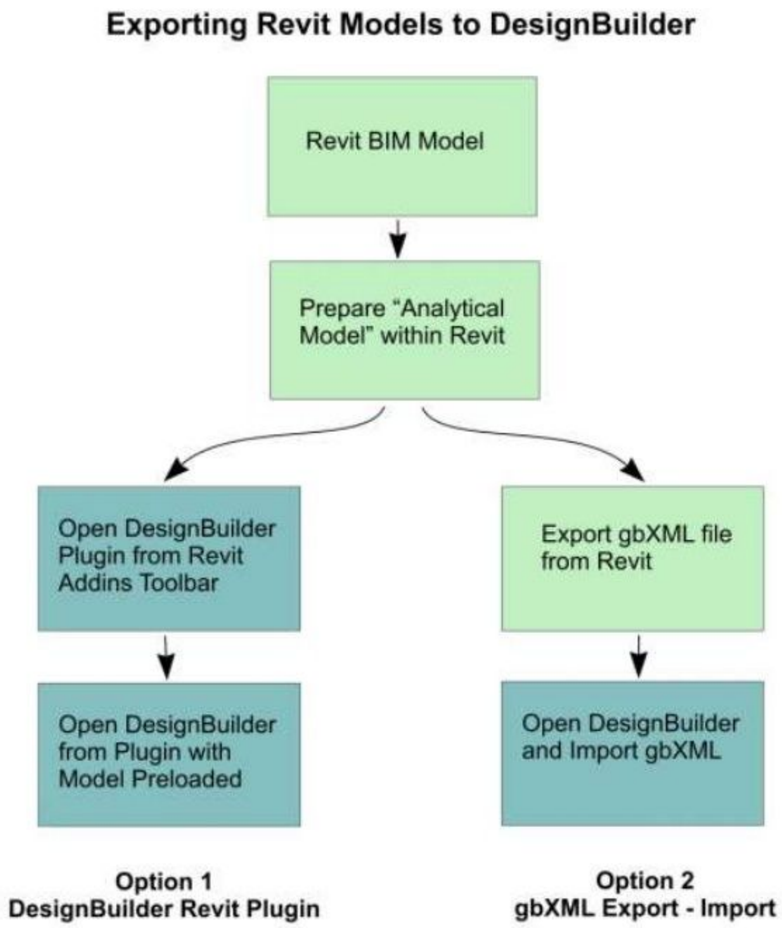


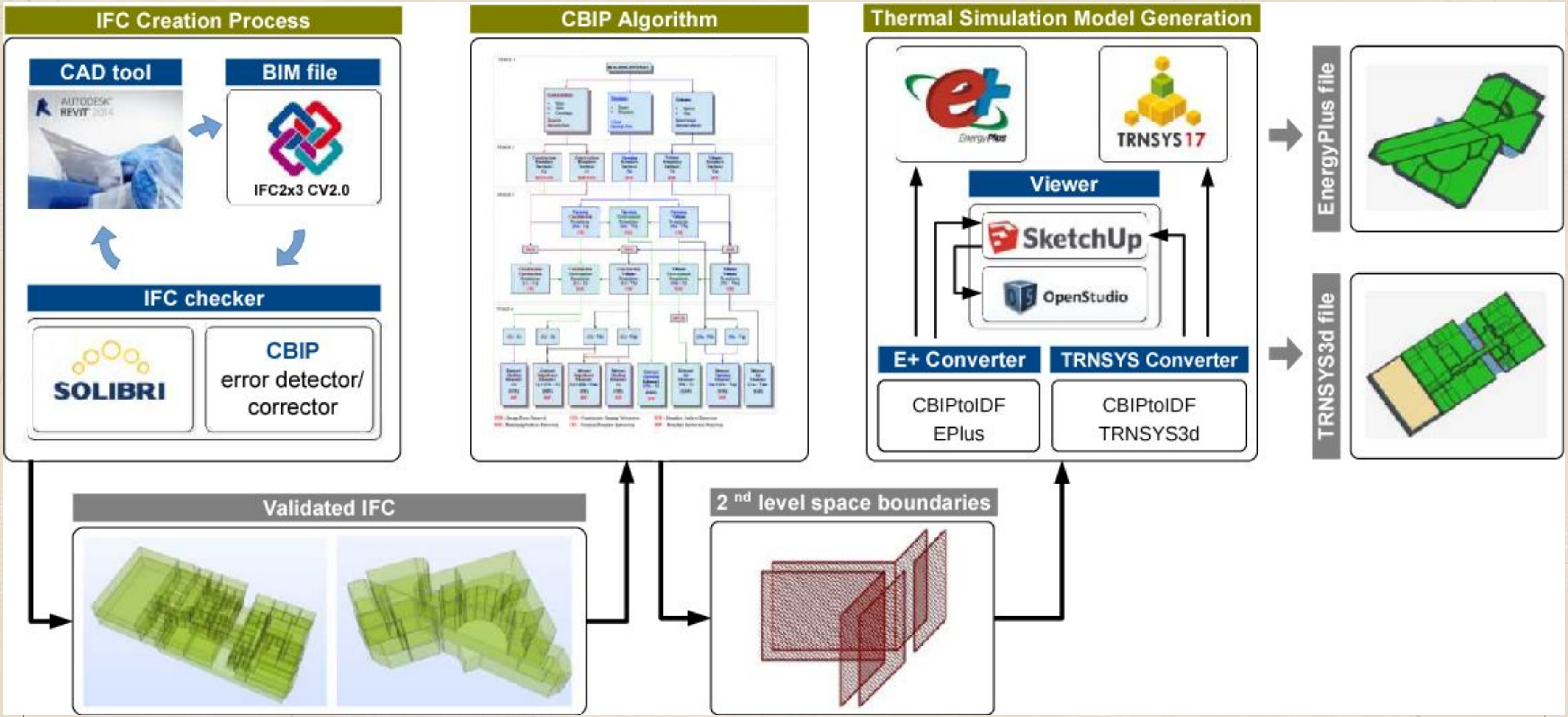
Software

ENVI-met simulation

urban spaces master plans, phy
morphology and help to draw
the role of built environment
materials and vegetation on pe
perception and thermal comfo

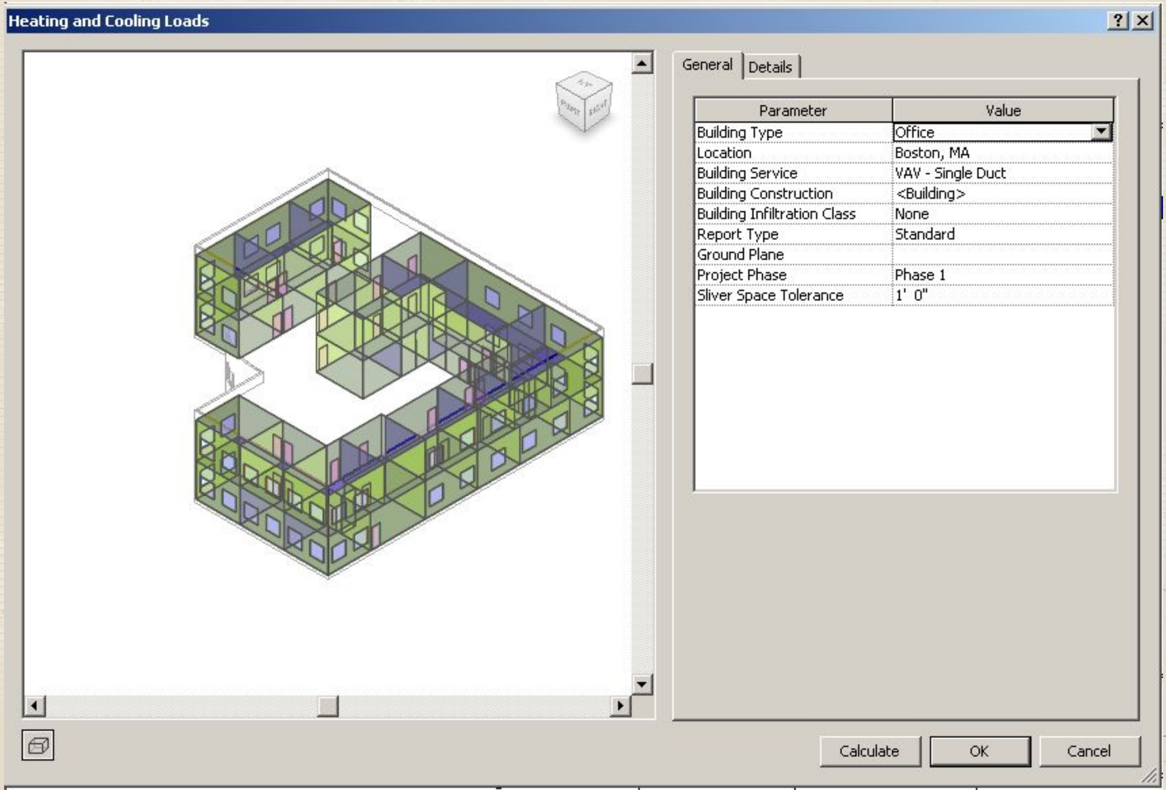



Exporting Revit Models to DesignBuilder
Revit BIM Model
Prepare "Analytical Model" within Revit
Open DesignBuilder Plugin from Revit Addins Toolbar
Export gbXML file from Revit
Open DesignBuilder from Plugin with Model Preloaded
Open DesignBuilder and Import gbXML
Option 1
DesignBuilder Revit Plugin
Option 2
gbXML Export - Import


IFC Creation Process
CAD tool
BIM file
IFC2x3 CV2.0
IFC checker
SOLIBRI
CBIP
error detector/
corrector
CBIP Algorithm
Thermal Simulation Model Generation
TRNSYS 17
Viewer
SketchUp
OpenStudio
E+ Converter
TRNSYS Converter
CBIPtoIDF
EPlus
CBIPtoIDF
TRNSYS3d
EnergyPlus file
TRNSYS3d file
Validated IFC
2 nd level space boundaries

Analytical Model Derived from gbXML

GREEN BUILDING XML



Data Sharing via IFC

IFC platform provides a bi-directional data link to major energy analysis software



BIM model

Energy analysis applications

gbXML Support

- HVAC/Energy
  - CADLine
    - Cymap
  - Carrier
    - Hourly Analysis Program (HAP)
  - DOE-2.2 & eQuest (via GBS)
  - Elite Software
  - EnergyPlus (via GBS)
  - Energy Soft*
  - Environmental Design Solutions Ltd.
    - Tas
  - IES, Ltd.
    - IES <Virtual Environment>
  - Trane
    - TRACE 700

- CAD/BIM
  - Autodesk
    - AutoCAD Architecture & MEP
    - Revit Architecture & MEP
    - Green Building Studio (GBS)
    - Ecotect
  - Bentley
    - Architecture
    - Building Mechanical Systems
    - Speedikon Architectural
  - Google
    - SketchUp
  - Graphisoft
    - ArchiCAD
    - Mac and Windows

gbXML


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MASDAR

Case Study

MASDAR

- Funded by Mubadala Development Company
- Designed by Foster + Partners
- Powered entirely on solar energy and other renewable energy sources
- Zero-carbon, zero-waste ecology
- Abu Dhabi Future Energy Company (ADFEC)
- Projected to cost US$22 billion
- Started in 2006,
- First phase 2009
- 2.3 sq mi
- 50,000 people
- 1,500 businesses



Case Study

MASDAR

- Masdar Institute of Science and Technology (MIST)
- Automobiles will be banned within the city
- Public mass transit and personal rapid transit systems
- City will be walled, to keep out the hot desert wind
- Narrow, shaded streets that will also funnel breezes
- Partners include through the Clean Tech Fund, GE, BP, Royal Dutch Shell, Mitsubishi, Rolls-Royce, Total S.A., Mitsui and Fiat

Case Study

MASDAR

- Power Sources
- 40 to 60 megawatt solar power plant, built by the German firm Conergy (construction activity)
- Larger facility and additional photovoltaic modules will be placed on rooftops to provide supplemental solar energy totaling 130 megawatts
- Wind farms will be established outside the city's perimeter capable of producing up to 20 megawatts
- Geothermal power
- Hydrogen power plant
- The city will not produce enough energy to power itself at night
- Import gas-fired power from Abu Dhabi’s grid
- Carbon accounting by exporting excess solar power to the grid during the day

MASDAR

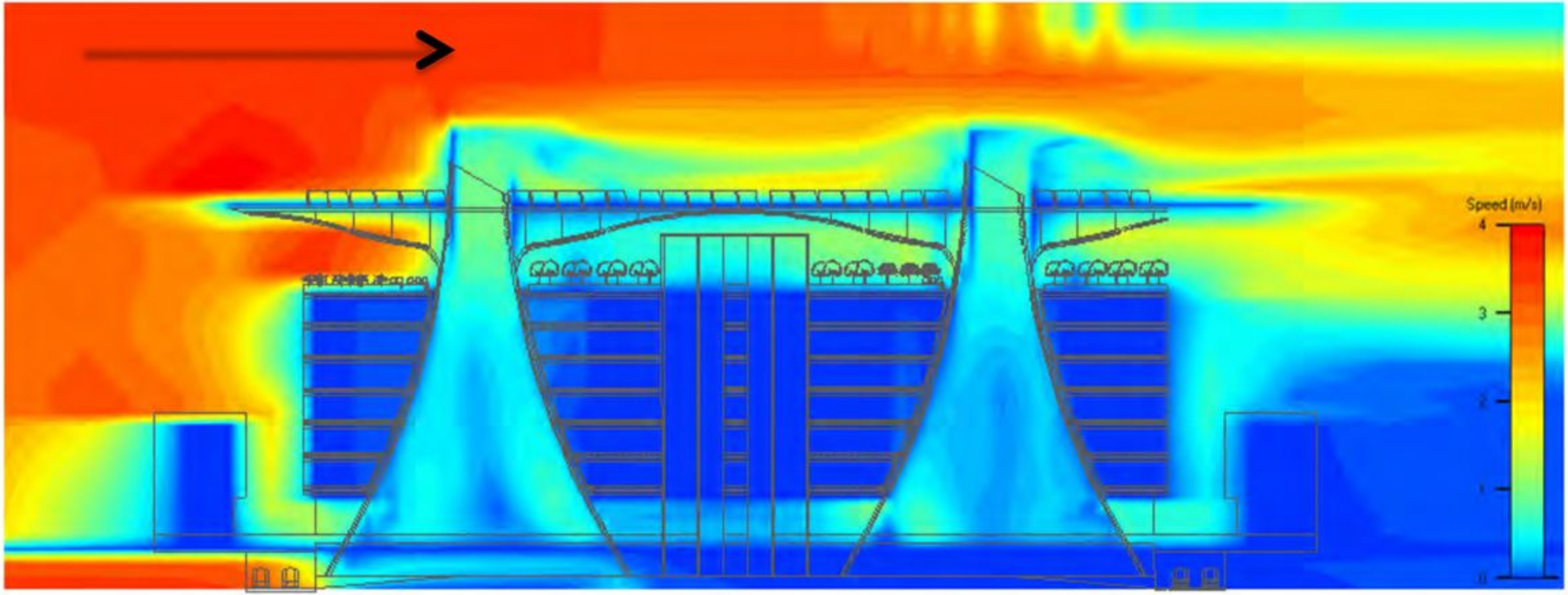
- Water
  - Solar-powered desalination plant
  - 60 percent lower water needs than similarly sized communities
  - 80 percent of the water used will be recycled
  - Attempt to reduce waste to zero
  - Biological waste will be used to create nutrient-rich soil and fertilizer
  - Waste incineration as an additional power source
  - Recycle



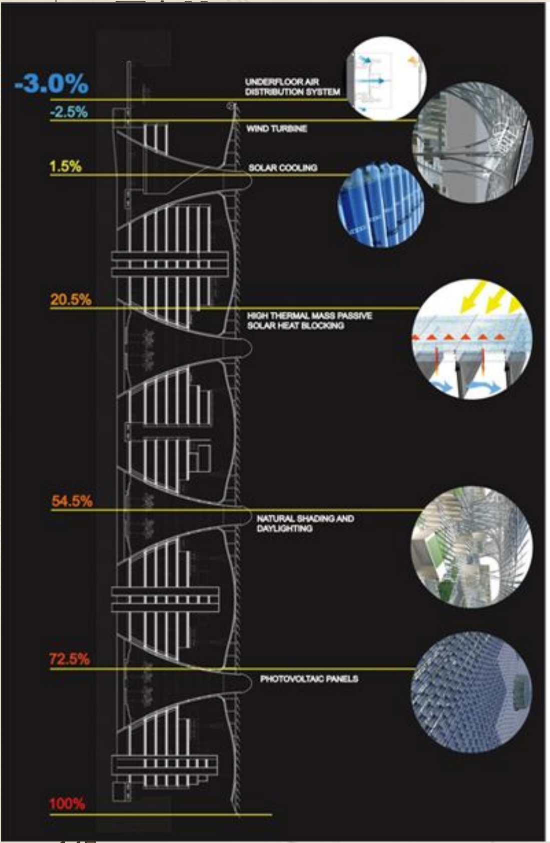
MASDAR–HEADQUARTERS

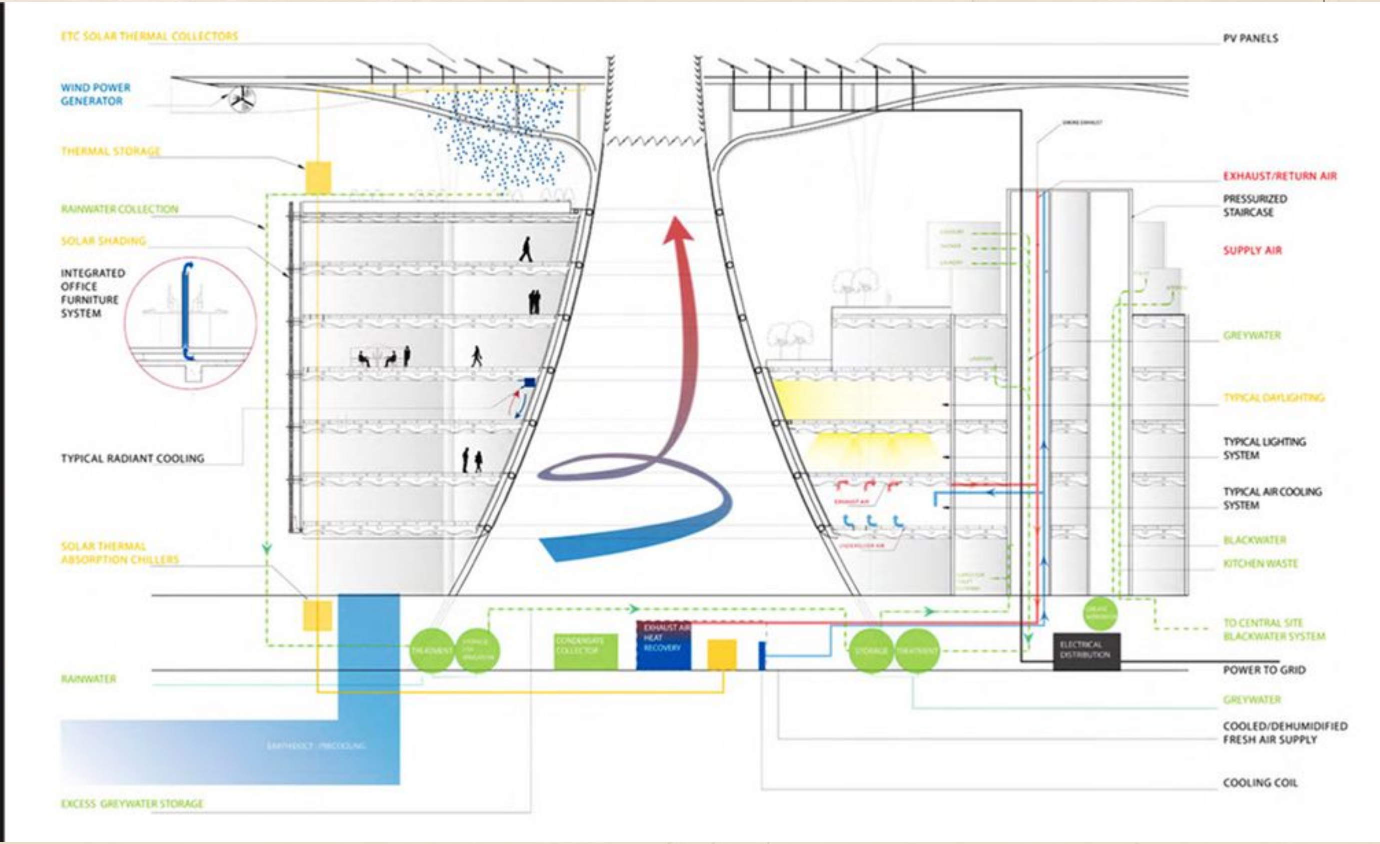


MASDAR-HQ-VENTILATION-STRATEGY

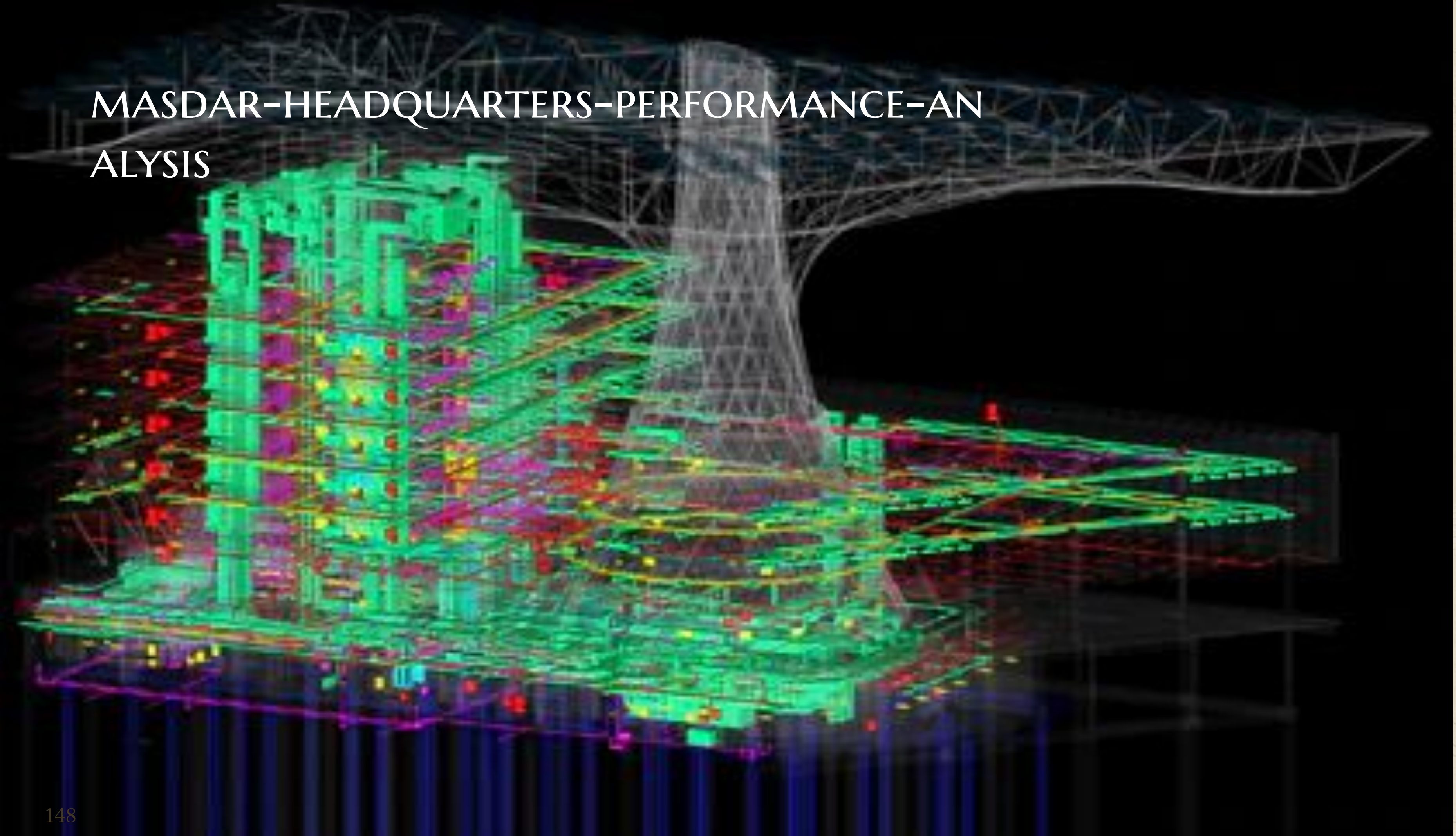


MASDAR-HQ-SUSTAINABILITY-STRATEGIES-DE





MASDAR-HEADQUARTERS-PERFORMANCE-ANALYSIS



Case Study

MASDAR SYSTEMS

- **Building operation**
- Electrical generation and distribution
- Electrical energy meters
- Water meters
- Mechanical systems
- Public health systems
- Lighting control system
- Automated shading system
- Automated atrium roof lights
- Vertical transportation
- Public address system
- Digital signage system
- Sun tracking system
- Irrigation system
- Water features
- Information portal system
- Freight tracking RFID system

- Personnel RFID system
- MASDAR RFID tracking system
- Ventilation system for catering facilities
- Kitchen equipment
- Point of sale system
- Waste system
- Audio visual systems
- Library data base and alarm system
- Automated book storage facility
- **Transportation**
- PRT - Management centre
- PRT - Security system
- PRT - Ticketing system
- Vehicle management system
- LRT - Light Rail Transit System

MASDAR SYSTEMS

- **Life Safety and Security**
- Seismic monitoring
- Structural anti-corrosion monitoring
- Fire detection/alarm system
- Fire Suppression systems
- Intruder detection system
- Closed circuit television system
- Access control system
- Emergency lighting system
- Oxygen depletion monitoring system
- Refrigerant leak detection system
- Water leak detection system
- Disabled refuge telephone system
- Fire fighters telephone system
- Smoke extract system
- Fire pump
- Sump pumps

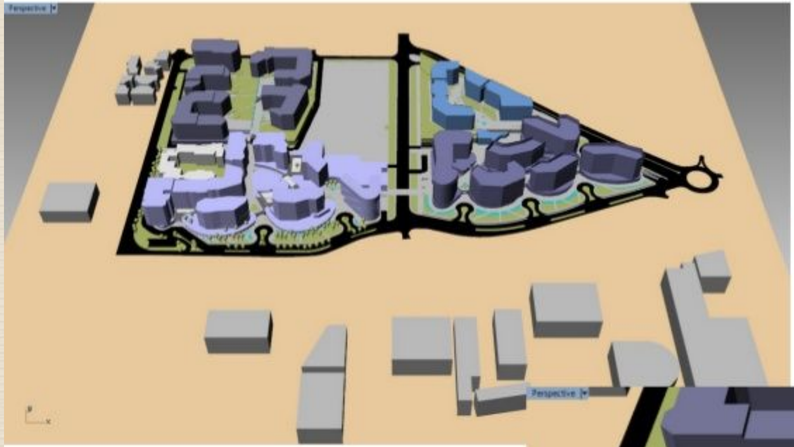
MASDAR SYSTEMS INTEGRATION

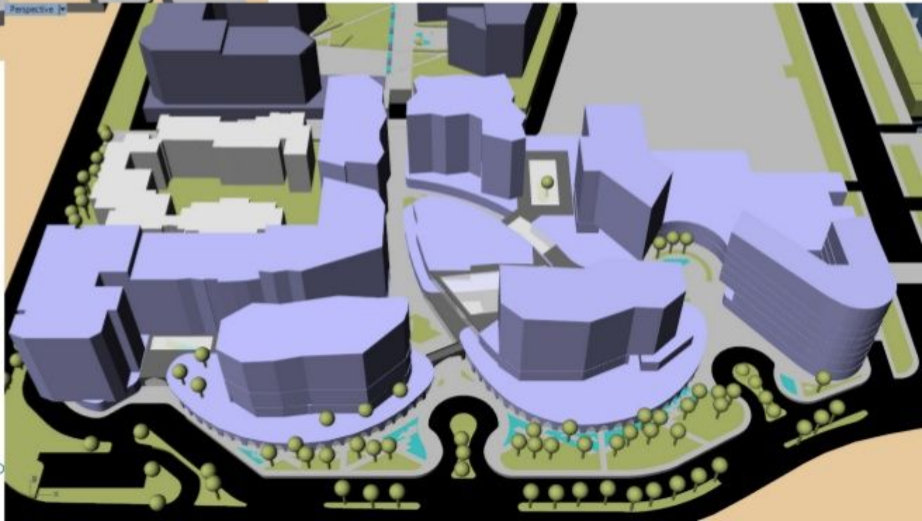
	Building operation	Electrical generation and distribution	Electrical energy meters	Water meters	Mechanical systems	Public health systems	Lighting control system	Automated shading system	Automated atrium roof lights	Vertical transportation	Public address system	Digital signage system	Sun tracking system	Irrigation system	Water features	Information portal system	Freight tracking RFID system	Personnel RFID system	MASDAR RFID tracking system	Ventilation system for catering facilities	Kitchen equipment	Point of sale system	Waste system	Audio visual systems	Library data base and alarm system	Automated book storage facility
MIST Control Centre		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Building operation																										
Electrical generation and distribution			X								X	X	X													
Electrical energy meters					X	X	X						X					X								
Water meters						X							X	X	X			X								
Mechanical systems								X	X		X	X	X					X		X						
Public health systems											X	X		X	X			X								
Lighting control system								X	X				X					X						X		
Automated shading system													X													
Automated atrium rooflights													X													
Vertical transportation											X	X						X								
Public address system												X						X								
Digital signage system																		X								
Sun tracking system																										
Irrigation system																										
Water features																										
Information portal system																	X				X	X	X			
Freight tracking RFID system																			X			X				
Personnel RFID system																			X			X			X	
MASDAR RFID tracking system																										
Ventilation system for catering facilities																										
Kitchen equipment																										
Point of sale system																										
Waste system																										
Audio visual systems																										
Library data base and alarm system																										X
Automated book storage facility																										
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Fire detection/alarm system																										
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PRT - Management centre																										
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PRT - Ticketing system																										
Vehicle management system																										
LRT - Light Rail Transit System																										

	Life Safety and Security	Seismic monitoring	Structural anti-corrosion monitoring	Fire detection/alarm system	Fire Suppression systems	Intruder detection system	Closed circuit television system	Access control system	Emergency lighting system	Oxygen depletion monitoring system	Refrigerant leak detection system	Water leak detection system	Disabled refuge telephone system	Fire fighters telephone system	Smoke extract system	Fire pump	Sump pumps
MIST Control Centre		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Building operation																	
Electrical generation and distribution		X			X							X					
Electrical energy meters																	
Water meters												X					
Mechanical systems		X		X	X					X	X				X		
Public health systems		X		X	X							X				X	X
Lighting control system						X	X										
Automated shading system																	
Automated atrium rooflights				X													
Vertical transportation		X		X			X	X									
Public address system		X		X	X					X	X	X					
Digital signage system		X		X	X					X	X	X					
Sun tracking system																	
Irrigation system																	
Water features																	
Information portal system																	
Freight tracking RFID system							X										
Personnel RFID system				X		X	X	X		X	X	X	X				
MASDAR RFID tracking system																	
Ventilation system for catering facilities				X													
Kitchen equipment																	
Point of sale system																	
Waste system																	
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Library data base and alarm system							X										
Automated book storage facility																	
Life Safety and Security																	
Seismic monitoring																	
Structural anti-corrosion monitoring																	
Fire detection/alarm system					X		X	X					X		X	X	
Fire Suppression systems																	
Intruder detection system							X	X									
Closed circuit television system								X		X	X	X	X				
Access control system																	
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	Transportation	PRT - Management centre	PRT - Security system	PRT - Ticketing system	Vehicle management system	LRT - Light Rail Transit System
MIST Control Centre		X	X	X	X	X
Building operation						
Electrical generation and distribution						
Electrical energy meters						
Water meters						
Mechanical systems					X	
Public health systems						
Lighting control system					X	
Automated shading system						
Automated atrium rooflights						
Vertical transportation						
Public address system		X				
Digital signage system		X				
Sun tracking system						
Irrigation system						
Water features						
Information portal system						
Freight tracking RFID system		X				
Personnel RFID system		X	X	X		X
MASDAR RFID tracking system						X
Ventilation system for catering facilities						
Kitchen equipment						
Point of sale system						
Waste system						
Audio visual systems						
Library data base and alarm system						
Automated book storage facility						
Life Safety and Security						
Seismic monitoring		X				
Structural anti-corrosion monitoring						
Fire detection/alarm system		X				
Fire Suppression systems		X				
Intruder detection system		X	X			
Closed circuit television system					X	
Access control system					X	
Emergency lighting system						
Oxygen depletion monitoring system						
Refrigerant leak detection system						
Water leak detection system						
Disabled refuge telephone system						
Fire fighters telephone system						
Smoke extract system						
Fire pump						
Sump pumps						
Transportation						
PRT - Management centre			X	X		
PRT - Security system				X		
PRT - Ticketing system						
Vehicle management system						
LRT - Light Rail Transit System						

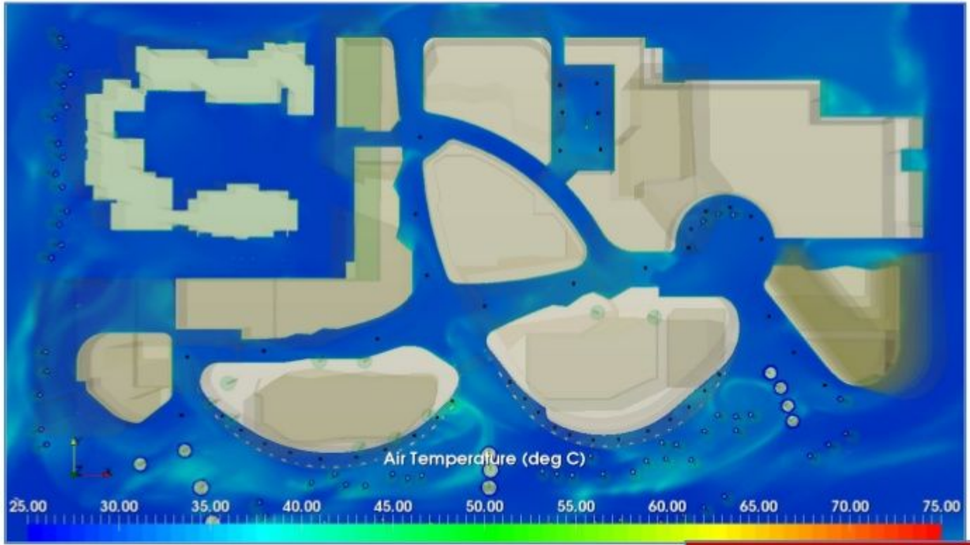
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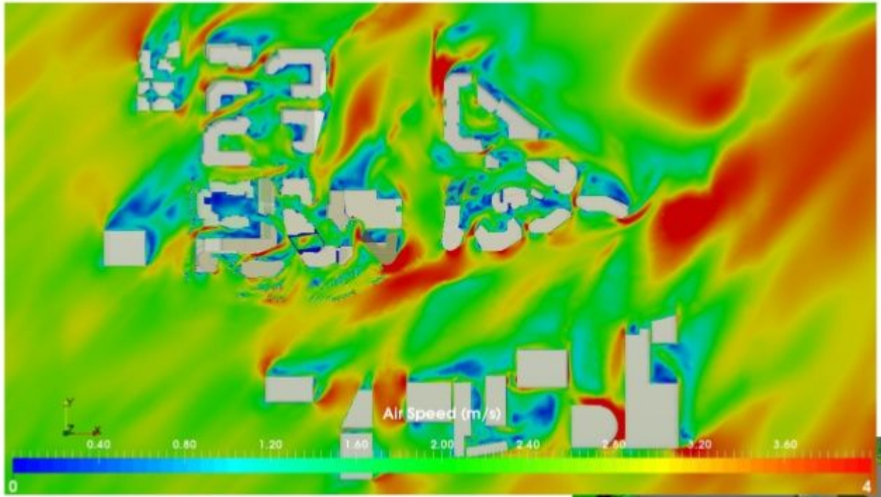
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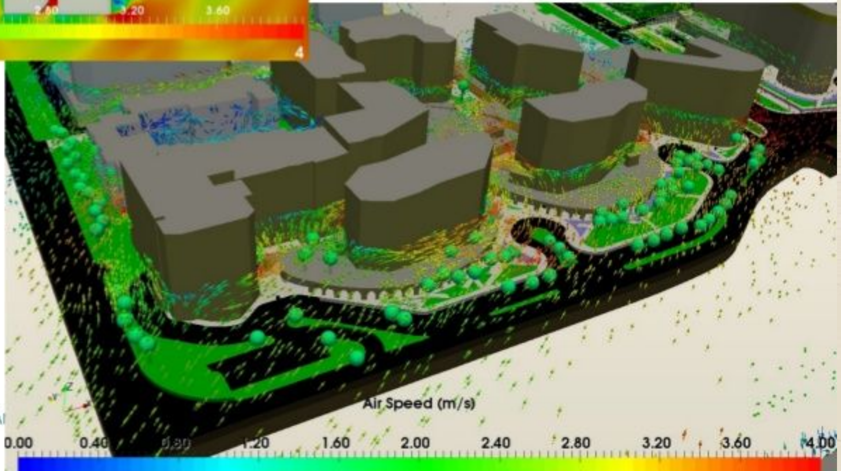
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Thanks!

Any questions?

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- oselim@bimarabia.com

